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By Prof. E. N. da C. Andrade, F.R.S.

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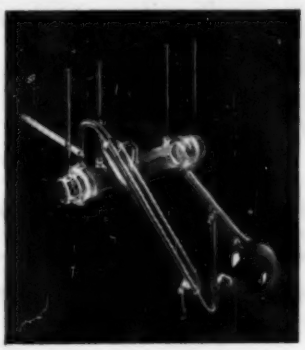

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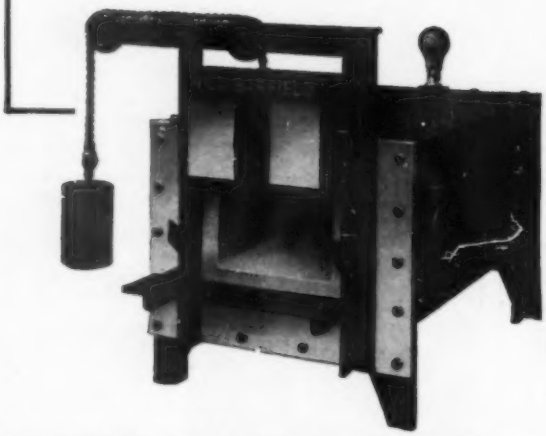

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# Education and Intellectual Freedom

IN a noteworthy address at the annual dinner of the University of London held on May 13, the American Ambassador, Mr. Kennedy, stressed the importance of the remaining free universities of the world as champions of the undisturbed liberty to seek and expound truth as it is and not 'truth' as it ought to be—in the interests of some totalitarian scheme. The spirit of tolerance and free inquiry has only been kept alive in Great Britain and in the United States by strenuous endeavour, and in spite of our enviable position we should not think that in either country the fight is over.

Mr. Kennedy's reminder of our responsibility to truth and justice was coupled with a warning of the danger which threatens to-day not only the quest for new truths regardless of their immediate value, which is the basis of true learning and scholastic integrity, but also education itself, in a world which has seen famous scholars driven into exile and universities staffed only by those who openly subscribe to a dominant political creed. Schools, colleges and universities are being forced to teach not what the professors know to be true, but rather what the political heads of the State want their youth to believe is true. Never was greater vigilance called for even in the free countries to see that the schools do not become the organs of any political party temporarily in control of the destinies of the State, or to permit them to mirror any teaching except the truth as nearly as it is possible to ascertain and impart truth.

It is well, indeed, to be reminded that the struggles by which academic freedom was established in the past are by no means over, for to recognize the threat of a harsher bondage of learning to politics is a long step towards rallying forces to meet the danger. Moreover, the conditions to-day tend to hinder the free exchange of ideas between scholars of different countries, through which the universities can function as agents of international appeasement. On one hand, eminent men of learning are liable to be excluded from certain totalitarian countries, while on the other, the utilization of academic and scientific activity for the advancement of national political ends characterizing those countries has in turn led to a more cautious attitude in other countries in expanding facilities for the movement of professors, lecturers or students from such countries, except under the most express guarantees.

Upon this situation, the recent volume* by Mr. S. H. Bailey, issued by the Royal Institute of International Affairs, throws a flood of light. While Mr. Bailey sets out with admirable lucidity the historical growth, the nature and the extent of the provision now made for research in universities and non-academic institutions and for teaching in higher, secondary and adult education on international relations in a number of European countries and in the United States of America, he never allows his survey to be overburdened with

* International Studies in Modern Education. By S. H. Bailey. Pp. xvii+309. (London: Oxford University Press, 1938.) 15s. net.

detail. Detail is there indeed, sufficient for those who wish to follow up particular aspects of the survey more fully, but even more valuable is Mr. Bailey's analysis of the factors involved and the conditions of progress in this field. Here he brings to light the special responsibilities of the universities, both in the field of research and in the moulding of an informed and alert public opinion, without which even the most enlightened leadership is doomed to frustration and failure.

Discussing the position of research in international relations, Mr. Bailey points out that the principal obstacle to objective investigations is not the inadequacy of the financial resources, the dearth of trained personnel or the absence of adequate materials, but the encroachments upon intellectual freedom. The full admission of the principle of intellectual freedom is a vital condition for the objective study of international relations, no less than for scientific work of any kind. The twist which has been given to the minds of many in the authoritarian State who carry the responsibility for guarding the scientific tradition makes it difficult to rely upon the objective value of the work of institutions in those countries. Even in scientific work, it is almost impossible to estimate at any given moment the pressure of the unseen hand of an authoritarian Government, and the collective study of international relations can easily become a travesty. A resonant dogmatism drowns the quieter tones of the cautious comment and query of the scientific investigator, and an exchange of ideas, accompanied by their critical examination, becomes impossible.

Mr. Bailey's sober criticism here and elsewhere should go far to convince scientific workers of the reality of the threat in every field, and of the importance of a determined effort for the rigid maintenance of a high academic standard no less in international studies than in scientific questions in the narrowest sense of the word, even at the cost of an apparent slowing down of the pace of development. The situation is essentially similar with regard to neutral institutions unconnected with a university, such as the Institute of Pacific Relations and the Royal Institute of International Affairs. It is as necessary as with the universities that such institutes should be independent of political or other affiliations, and be precluded from expressing a corporate opinion if the research conducted by them is to be of real value.

Besides outlining the essential conditions for research institutions in this field, Mr. Bailey's notes on the development of the study of international relations in higher education deserve attention. He comments on the devastating effect in the social services of intensive specialization and the need for a general view for the comprehension of social phenomena—and the increasing difficulty of obtaining it—the tendency of students in one branch to overlook the contributions which workers in other fields can make to their work, and on the obstacle which is presented by preoccupation with professional training. In respect of adult education, his criticism of both the issue and the supply of publications of all kinds deserves attention, particularly in respect of those coming from organizations advocating policies, whether Government or not.

In both the sphere of research and in the university, the emphasis on the need for objective investigation and objective teaching is unmistakable, and Mr. Bailey directs attention particularly to the influence of the reaction against objective teaching in secondary education. In Germany, Italy and the U.S.S.R., the educational policy tends not to prevent the study of international relations but to subordinate it to the immediate political needs of the regimes in power. This in turn leads to a reaction in the field of secondary education corresponding with the close watch over their academic reputations kept by universities in countries where freedom of expression of opinion is still permitted. Educationists in such countries hesitate to encourage the movement of teachers and children to countries where freedom of expression of opinion is no longer tolerated and an active policy of political indoctrination pursued, and are also reluctant to receive teachers from authoritarian countries without the most explicit guarantees and the provision of safeguards against foreign propaganda.

The situation is thus not one which scientific workers can contemplate without concern. The obstacles to free exchange of thought across national frontiers no less than inside many of those frontiers are growing just when science has in many ways annihilated distance and incredibly multiplied means of communication. Even the almost unlimited possibilities offered by the natural and applied sciences for conveying to the mind a sense of the unity of knowledge and the ubiquitous results of scientific research, and in encouraging the development of the sense of human solidarity and reciprocal good will, can scarcely be utilized in such an atmosphere. All the more important it is

that scientific workers should not shirk their responsibility for upholding freedom of thought and investigation in countries where this principle is still honoured, of guarding against abuse of that freedom, of extending the spirit of impartial scientific inquiry into the many complex social, economic and international problems at present so largely dominated by prejudice, and of promoting within their own land and across its frontiers a spirit of respect for facts and the rights of others. Upon such a basis alone can be based alike the citizenship which permits enlightened leadership and the understanding and good will which establish justice and peace between nations.

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# A Philosophy for Socialism

**A Philosophy for a Modern Man**
By H. Levy. Pp. 287. (London : Victor Gollancz, Ltd., 1938.) 7*s*. 6*d*. net.

ALARMED discontent pervades the minds of most who reflect on the present state of our social organization, or who have to play some conscious part, small or great, in its conduct. Some diagnose the trouble as due to an upheaval in the ordained stratification of society, accompanied by and made more evil by failure in the mutual duties of the respective strata (or classes). Their remedy, in general terms, is to restore order mitigated by a cautious benevolence. But in their camp are not a few fleeing travellers throwing their load to the pursuing pack in a flurried haste, which, however, does not prevent a determination to make their own property the last sacrifice.

Others see that change is inevitable and press ruthlessly towards the realization of their own conception. They abstract social organization from the individuals which compose a society and would give to these a meaning and indeed an existence only for and through the society. They, like the first group, believe in duty, and that true freedom and happiness can be found only in obedience to duty, but it is fair to make the distinction that the new categorical imperative depends on the will of certain individuals, the old on the fact or the tradition that it is the will of God.

Those who wish to understand the object of Prof. Levy's sincere and vivid book may well begin by reading first the last chapter. He thinks that efforts to "harness the forces of production to the well-being of the people" must fail, and that the failure is inevitable, because hitherto "every form of society has been organised internally to serve the material and spiritual interests of a dominant class, by using the labour power of a subordinate class". His hope is for the emergence of a non-capitalistic, one-class organization of society.

Now the first of the groups to which I have referred believe that their political creed is based on a religious and metaphysical philosophy ; the second group plead in their support a somewhat crude adaptation of the Hegelian dialectic. Prof. Levy hopes that he has supplied a philosophy which will show that the change he wishes is in the natural order of the universe, is, in fact almost inevitable, but can be accelerated by the conscious activities of men of good intention. It follows closely Marxian dialectical materialism, but is reinforced by interpretation of the history of recent years, and by Prof. Levy's wider knowledge of economics and of physical and natural science. "For us," he writes, "the problems of philosophy are resolved into those of guiding ourselves and others towards this classless society."

I am not quite sure that philosophy with an alien purpose is likely to be a very sound philosophy, or that the wish to make it a support for a social doctrine may not lead it into waters as strange as it was led by the intention to prove or to disprove dogmatic religion. But probably I am abnormal in that respect, as it seems to be a comforting habit to attach a philosophy to every new social or scientific discovery ; and without doubt Prof. Levy has compounded a very fortifying draft.

Within a brief space, it is impossible to describe, and therefore foolish to pretend to criticize this "Philosophy for a Modern Man". It begins by explaining a methodology which employs what is to me the new and illuminating conception of 'isolates'. An isolate is a thing or process, or group of things and processes, the behaviour of which you study either by isolating it physically as in a laboratory experiment, or by abstraction in thought, so as to understand how far that behaviour is self-determined. But outside the conditions of the laboratory, and to a smaller extent even within them, your isolate is in contact with a larger isolate, and that again with one still larger. With your new knowledge you can now study the interactions between internal and external relations. But you have always to remember that your object of study, whether statistical or qualitative, is an isolate, and a way to knowledge, rather than knowledge itself.

The world is a changing world and every isolate and its relations are in constant change. Quantitative changes pass into qualitative changes. Under the very stringent conditions of laboratory experiment, such changes are sometimes reversible, but in biological events the series of changes, although they follow in orderly series, are not reversible. Hence the observation of experiments has to be replaced by the interpretation of history. It follows, therefore, that a philosophy of history has to be part of the philosophy of a modern man, and one of the most cogent and illuminating parts of Prof. Levy's book is his description and interpretation of the rise and failure of previous organizations of society, leading to his thesis that we are at present in a critical phase which will pass inevitably into the one-class society of the future.

P. CHALMERS MITCHELL.

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# Skull Morphology

## The Development of the Vertebrate Skull

By Dr. G. R. de Beer. Pp. xxiv + 552 + 143 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1937.) 30*s*. net.

IT is more than sixty years (1877) since the appearance of the first general text-book on "The Morphology of the Skull" by Parker and Bettany, a work excellent in its day but now out of date. The most important general work on the subject since then is the part on the development of the skeleton of the head contributed by E. Gaupp to Hertwig's well-known "Handbuch" (1906). It marked a great advance in our knowledge, more especially of the development of the cartilaginous framework of the skull and visceral arches. But a vast amount of work has been done since on the skull, and no one has made more important contributions than Dr. de Beer himself, whose series of detailed studies on the development of the head and skull in various vertebrates from cyclostome to mammal, published from 1922 onwards, form the basis for this fine monograph illustrated by 143 plates containing a vast number of figures most of which are the author's own.

The volume begins with a historical review of work done on cartilage, 'cartilage-bones', and 'membrane-bones', and their relationships from the histological, morphological and phylogenetic points of view. There follow discussions on the segmental composition of the skull, the determination of the exact position of its hind limit, and the craniogenic materials of which it is composed. The second, or systematic section, contains detailed accounts of the development of the skull in typical examples of the various groups of Craniata from the lamprey to man. A third, comparative, section deals with the general morphological consideration of certain cartilages and bones of particular interest; while in a fourth and general section the author returns to such more general questions as the growth of the skull, the effects of heterochrony, the experimental evidence as to the causal relationships and interdependence of the parts. This section also contains most useful summaries of the special characteristics of the various classes.

A distinctive feature of this monograph is the detailed account of the relation borne by the skeletal parts to the neighbouring nerves and blood-vessels, and their clear delineation in the figures. The importance of these relations had already been emphasized by Gaupp and particularly by Allis, and they have been worked out in various forms by de Beer with remarkable success.

Three main questions are dealt with in this book: the fundamental segmentation of the head, and the attempt to trace in development how many segments, corresponding to those of the rest of the body, contribute to the building up of this special region; the development and homology of the various skeletal parts, both cartilaginous and bony, and how far they can be distinguished as constant elements throughout the Craniata; and lastly, the actual phylogeny of the skull and visceral arches in their manifold adaptations in the different groups both living and extinct. All fascinating problems.

Only a few points can be mentioned in this review. It was Balfour who first showed that the head-region consists of segments homodynamous with those of the trunk, and van Wijhe who clearly distinguished between the more dorsal myotomes giving rise to myomeres innervated by the ventral segmental motor nerve-roots, and the more ventral unsegmented lateral plate giving rise to muscles supplied from the segmental dorsal nerve-roots. De Beer concludes: that there are three, and three only, so-called prootic segments in front of the auditory capsule, and a varying number of metotic segments behind the capsule in different species and groups (for example, nine head-segments altogether in *Squalus*, eleven in *Lepidosteus*, six in *Amblystoma*, nine in *Lacerta*);

that, as shown by Koltzoff, the complete uninterrupted series appears in the embryo and persists even in the adult cyclostome (*Petromyzon*). Moreover, he confirms Ziegler and Goodrich, as against van Wijhe, in maintaining that no segment is suppressed in the region of the third prootic, and that the orderly sequence of myotomes and nerves is here preserved. Further, he shows that in Gnathostomes not more than two myomeres are suppressed behind by the overgrowth of the auditory capsule during the course of development, the sixth of the series being usually the first to produce permanent muscle. Consequently, Fürbringer's assumption that a large number of metotic segments have in the course of phylogeny been eliminated, already severely criticized by Goodrich, is here rejected.

The exact position of the occipital joint, which varies in different forms according as more or fewer trunk segments are assimilated from behind and contribute to the formation of the skull, is another point admirably treated. The homology of the trabeculæ cranii has been a subject of much controversy. Long ago, Huxley suggested that they were derived not from the axial chrondrocranium itself but from an anterior pair of visceral arches. From fresh evidence de Beer inclines to the view of Allis that they are, indeed, premandibular arches, and that the pair of gill-slits between them and the mandibular arches has been lost. The text ends with a useful list of problems which remain to be solved by future research.

Throughout full justice is done to the work of previous authors, whose observations and conclusions are carefully considered, and the very complete bibliography at the end of the volume is ingeniously set out so as to refer to the subject dealt with and the page on which the reference occurs.

The writing of such a book must have entailed an immense amount of careful work, and students of the morphology of vertebrates owe a debt of gratitude to the author for having carried it out so successfully. The publishers are to be congratulated on having brought out such a handsome volume at so moderate a price.

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# Conceptions and Exponents of Human Culture

## The History of Ethnological Theory

By Prof. Robert H. Lowie. Pp. xiii+296. (London: G. Harrap and Co., Ltd., 1937.) 10*s*. 6*d*. net.

IN his history of ethnological theory, Prof. Lowie gives a survey of the course of progress in the theoretical study of culture and of the growth of knowledge through the improvement of technique for gathering the requisite information. For these his wide knowledge of the literature of the subject and his critical detachment render him peculiarly well fitted, and he has done so in a most interesting manner. Although the history covers a period of some hundred years, it records the infancy and adolescence of a new branch of learning which only now is attaining recognized scientific status.

The approach by students to ethnology has been very varied. The mental training required for proficiency in law, history, biology, medicine, or philosophy has necessarily given a bias in the several students towards some particular aspect of ethnology and to the manner in which it has been studied. There must also be taken into account the prevalent scientific and philosophical tendencies which must inevitably influence the investigator. For example, ethnologists were irresistibly inclined to adopt the prevailing biological concepts at the time when evolution was in the air.

The subject-matter of ethnology, unlike that of the physical or natural sciences, cannot be discussed purely objectively, as it deals with investigations into human culture and behaviour undertaken by human beings with different personal equations. The conclusions and at times even the integrity of the writers have been criticized by other students, who also exhibit very human traits—lack of poise, rancour, and even distortion being not unknown. The history of ethnological theory is thus bound up with the personality of those who were creating the science, and consequently Prof. Lowie has found it necessary to consider their idiosyncrasies as well as their contributions to ethnology. These personal sketches of dead and living ethnologists are most illuminating and are presented with a dispassionate judgment to which little exception can be made.

The following observations are extracted from Prof. Lowie's final chapter, "Retrospect and Prospect". He refers to four errors that are now definitely discarded: that of culture being a simple function of physical conditions and natural resources. Prelogical primitiveness. Primitive intellectualism. Racialism: since the comparatively small differences in the innate mental endowment of races are not able to account for all the differences in cultural development; such, for example, as the profusion of secret societies in some areas and their absence in others.

There is general agreement that Bastian's 'genetic law' cannot explain specific coincidences. While no one has ever denied diffusion *in toto*, its importance has been established beyond cavil, and what nowadays divides scholars is merely the intensity of their concern with this principle and the nature of their methodological safeguards against error. Even the most fervid functionalists occasionally turn to historical sequence. As Dr. Elsie Clews Parsons remarks, "Wisdom in ethnology, as in life, lies in having more than one method of approach". Within the space of half a century a number of questions have been settled—so far as we can judge, definitively. No one now defends the three-stage theory of economic progress. That promiscuity now exists nowhere and is an unproved hypothesis for the past is the view of most living ethnologists. That the family and not the clan is the basic social unit is also widely held, though Durkheim still maintains the idea of the priority of the clan.

Neither psychology or ethnology can be reduced to the other. Ethnology enlarges the psychologist's ken, demonstrating the scope of social patterning in individual behaviour. The ethnologist, inevitably bound to use terms relating to the mind, uses the determinations of scientific psychology prophylactically against the snares of vulgar psychology; and constructively in refining his analysis of regional differences and of particular processes.

Being a science, ethnology implies an orderly arrangement of its data, the verifiability of its findings, a logical basis for its conclusions. But in conforming to the canons of all science, it must not adopt the particular techniques of physics, biology, or geology except where the cultural data as such demand such recourse.

A. C. HADDON.

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# Mathematics for Economists

**Mathematical Analysis for Economists**

By R. G. D. Allen. (London School of Economics and Political Science: Studies in Statistics and Scientific Method, edited by A. L. Bowley and A. Wolf.) Pp. xvi+548. (London: Macmillan and Co., Ltd., 1938.) 31*s.* 6*d.* net.

THE aim of this book is to provide a course of pure mathematics that will be useful to students of economics. The earlier chapters, which deal with numbers and variables and their representation, with analytical geometry, the elements of the calculus, etc., will, as intended by the author, be helpful and valuable to the student of economics who has little mathematical equipment but must learn more in order to follow the modern treatment of economic theory, for which economists are considerably indebted to the late Prof. Alfred Marshall and later writers. The later chapters deal with functions of two or more variables, with differentials, problems of maximum and minimum values, differential equations, expansions and determinants, while a final chapter discusses some problems in the calculus of variations. At certain stages, especially in the later chapters, problems definitely connected with economics are discussed from the theoretical point of view, but the author has relied largely on a careful choice of examples to lead the reader from the mathematics to the practical application. These examples are particularly well arranged and have been chosen with considerable skill, so that, taking the book as a whole, we think that it will be found interesting to many economists who have passed the stage of student in the educational sense but are still students in the wider sense of the term.

There is little in the way of adverse comment that need be urged against the book, but we may suggest that in future editions an occasional verbal rearrangement might be advantageous: for example, on p. 297, where, in dealing with partial derivatives, the author refers to "two vertical sections" perpendicular to each axis, the wording may give the impression that there are only two possible vertical sections. It becomes clear on the next page that this is not what is meant, but a slight alteration would ease the path of the reader.

From time to time mathematical books are published which have been prepared by the authors for particular groups of students, and in the not wholly convincing "short bibliography" one book is mentioned, "Calculus made Easy", which was originally intended for engineering students; this is a long way from economics. A type of work bearing some points of contact with economics is that of the actuary, but the mathematical textbook used by actuarial students in Great Britain has little likeness to the book before us; Mr. Allen might, however, in dealing with interest, adopt for future editions the international actuarial notation.

In reading this interesting book, it was borne in on us that though each type of student will inevitably read his mathematics for a specific reason, it would sometimes be wise for him to put

aside books which deal with mathematics from his own point of view and to study, instead, books written for a different type of student. Such a course would not only improve his mathematical equipment, but also it would convey to him that there is a field of work outside his own, which may be linked with his by the fundamental mathematics or in other ways. The thoughtful student might thus be led to a broadminded sympathy with other subjects and to the possible enlargement of his own. Mr. Allen's book contains much that could be read by students who have no direct interest in economics, and it can be whole-heartedly recommended. W. P. E.

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# Metallic Systems

**Die heterogenen Gleichgewichte**

(Handbuch der Metallphysik, herausgegeben von Prof. Dr. G. Masing, Band 2.) Von Prof. Rudolf Vogel. Pp. xxiii+737. (Leipzig: Akademische Verlags gesellschaft, m.b.H., 1938.) 68 gold marks.

THE previously published parts of the "Handbuch der Metallphysik" have dealt with metallic structure and the plastic working of metals. The high standard set by those parts of Prof. Masing's fine work is worthily upheld by this volume, the subject of which is more difficult to treat successfully because of its immense scope. The author has not attempted to confine attention to metallic systems, but, for reasons which are explained in an introduction and with which few will disagree, has taken the broadest point of view, concentrating on physico-chemical fundamentals and illustrating them by examples of both non-metallic and metallic systems.

The book is divided into five sections, in the first of which the principles of thermodynamics are somewhat briefly stated in order to explain the phase rule and the influence of temperature and pressure on equilibrium. The second section, on single component systems, deals with vapour pressure and melting point curves, the triple point, the derivation of the $p$-$t$ diagram from free energy considerations, and polymorphism; and describes the cases of sulphur, ammonium nitrate, silica, water, phosphorus, and allotropic metals. The thermodynamic criteria of equilibrium—the minimum free energy of the system, and the equal partial free energies of the components—are also explained and their implications illustrated by free energy diagrams. Binary systems are considered in the third section, which is about equally divided between equilibria in the presence of a vapour phase, and condensed systems, in which the pressure variable can be neglected. Particular metallic systems are not discussed in detail, but a list is given of references to the literature concerning more than 450 systems. The thermodynamic treatment of equilibrium of the second section is here extended to systems of two components.

In the fourth section, equilibria of three-component systems in the presence of a gaseous phase, occupy only 30 out of 350 pages, the remainder being of immediate interest to the metallographer, since it provides a meticulously thorough explanation of the possible types of ternary equilibrium diagram, illustrated by detailed descriptions of the aluminium-magnesium-copper, iron-nickel-phosphorus, iron-nickel-tungsten, iron-carbon-cobalt, and iron-iron sulphide-iron carbide systems. A list is given of references to the literature dealing with more than 200 ternary metallic systems. The use of free energy diagrams is further extended. The comparatively small amount of knowledge available, concerning systems of more than three components, is evident from the shortness of the final section, in which the difficulties of presentation and the vast field awaiting exploration are clearly indicated. A list of 22 quaternary metallic systems, which have been investigated, emphasizes the artificiality of the distinction between "Legierungen ohne Eisen" and "Legierungen mit Eisen" by including, among the latter, the work of Gwyer, Phillips and Mann on the Fe-Al-Cu-Si system.

This book is not to be recommended for reading in the train, and most metallurgists will probably require a large dose of "Lewis and Randall" before digesting the whole of it. On the other hand, it is not sufficiently comprehensive to form a reference book on heterogeneous equilibria for the physical chemist. It is, in fact, a compromise, which attains considerably more than might be expected from part of a treatise on "Metallphysik", for it not only explains the characteristics of equilibrium diagrams for metallic systems, but it also presents to the metallurgist a wider scope than he is wont to consider, and encourages—indeed, almost demands—wider reading. Comprehensive references are given and the indexing is adequate. The publishers have done their work well: good printing, excellent diagrams, and a handsome binding complete a valuable addition to metallurgical literature.

H. W. G. H.

### Constructive Democracy

By Sir Ernest Simon, the Rt. Hon. the Viscount Halifax, Arthur Bryant, R. Bassett, the Marquess of Lothian, the Rt. Hon. C. R. Attlee, Sir William Beveridge, E. J. Patterson, Sir Alfred Zimmern, H. D. Henderson, Sir Arthur Salter, Moritz J. Bonn. Pp. 249. (London: George Allen and Unwin, Ltd., 1938.) 7*s*. 6*d*. net.

THERE can now be few scientific workers who are unaware of the threat to science itself which the disappearance of the spirit of free inquiry in the totalitarian States constitutes, and to any such Sir Alfred Zimmern's pertinent address on "Learning and Leadership" can be heartily commended. The problem of establishing in the democratic States conditions under which the fullest use can be made of science grows ever more urgent in the interests of science no less than of democracy itself. Without the spirit of free inquiry the fundamental disciplines themselves decay, and without them applied science cannot flourish long. This timely essay is both a warning and a challenge to thought and co-operation from scientific workers themselves, and for it alone the volume would be welcome.

There is, however, much else in these essays or addresses, for all their diversity, which has claims on the attention of scientific workers. Sir William Beveridge, for example, writing on "Planning under Democracy", reiterates his proposal for an economic general staff as a means of assisting the impartial scientific study of political, social and economic questions. Between them, these essays state very fairly the claims which democracy has upon the serious attention of the scientific worker, directions in which he might well seek to qualify himself as a citizen without impairing his professional standards or code, and ways in which he might co-operate in the solution of problems urgently demanding attention if standards and ideals which he cherishes no less than other citizens of a democratic State are not to be overthrown by the dictatorships.

### The Cause of Cancer

By David Brownlie. Pp. viii+208. (London: Chapman and Hall, Ltd., 1938.) 7*s*. 6*d*. net.

THE author, a fuel technologist, presents the theory that most human cancer is caused by the entry into the body, mainly in the food, of carcinogenic compounds formed by carbonization. He would have us believe that the cooking of food in internally heated gas ovens, and the smoking of meat and fish, are the principal sources of these dangerous substances, but that the breathing of traces of leaking and partially unconsumed domestic gas also contributes.

The evidence here presented is quite inadequate to support the author's theory with any sound basis of experience. In fact, we may even ask if the high-boiling carcinogenic hydrocarbons are actually present in the gas supply. There are also a number of facts which seem to deny that any but a restricted range of cancers could be due to such a cause. For example, two strains of mice may be bred for many generations side by side in the same animal house, receiving the same food, breathing the same (polluted or unpolluted) air; yet 90 per cent of the females of one strain get cancer while only a small proportion of the other strain suffer from the disease. Moreover, contrary to the author's opinion (p. 20), there is excellent evidence that typical cancer occurs in a variety of animal species. F. D.

### Heredity and Politics

By Prof. J. B. S. Haldane. Pp. 185. (London: George Allen and Unwin, Ltd., 1938.) 7*s*. 6*d*. net.

THIS book has been skilfully fashioned out of the Muirhead Lectures given by the author at the University of Birmingham last year. It is addressed to such as are unacquainted with the science of genetics, but who are attracted or disturbed by eugenic doctrines. In relation to its purpose, it is an admirable book. Its language is simple and non-technical, yet precise, and its style is smooth and pleasing.

It consists of two parts, the first being a lucid and attractive exposition of the principles of genetics so far as they apply to the human subject, whilst the second half of the book treats with studied fairness of such controversial questions as the fundamental inequality of man, the sterilization of the unfit, the differential birth-rate, the innate superiority of certain races and certain social classes, and the effects of racial crossing. The author is uniquely equipped to deal with these matters, and to those who wish to become acquainted with such scientific knowledge concerning them as exists, and who would care to know what one of the really outstanding intellects of our time thinks about them, this book is strongly recommended. It could be read with great profit by the medical student who seeks an introduction to human genetics. F. A. E. C.

### Analytical Chemistry

Based on the German Text of Prof. F. P. Treadwell. Translated and revised by Prof. William T. Hall. Vol. 1: Qualitative Analysis. Ninth English edition. Pp. x+630. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1937.) 22*s*. 6*d*. net.

TREADWELL'S "Analytical Chemistry" belongs to the classics of our teaching literature. It now enters its ninth English edition under the guidance of Prof. W. T. Hall. In the interim since the previous edition there have been many changes introduced into modern chemical theory, and these have necessitated alterations in the book. Part 1, dealing with general principles, has been largely rewritten; part 2 is rearranged in the order of the analytical procedure followed by the student.

Much new material is to be found; for example, tests based on drop reactions and a certain amount of semi-microchemical analysis. Other matter has been discarded or shortened to keep the book within bounds: for example, the sections on spectroscopy and on the analysis of the rare metals.

It is valuable to have such books kept frequently revised, and the users will owe a debt of gratitude to the author for his labours. Criticism of such a successful work is superfluous.

# The Benjamin Franklin Memorial, Philadelphia

THREE days of stately ceremonies, including the unveiling of a heroic white marble statue of Benjamin Franklin, lectures on pure and applied science, a two million dollar philatelic exhibition, military and naval displays, exhibits contrasting the science of Franklin's time with that of to-day, marked the formal dedication of the Benjamin Franklin Memorial on May 19–21, at the Franklin Institute, Philadelphia, Pa.

STATUE OF BENJAMIN FRANKLIN IN THE FRANKLIN HALL, FRANKLIN INSTITUTE, PHILADELPHIA

The French Ambassador to the United States, Count René Doynel de Saint Quentin; Herbert C. Hoover, former President of the United States; Daniel C. Roper, Secretary of Commerce; George Wharton Pepper, formerly a senator of the United States; Roland S. Morris, president of the American Philosophical Society and formerly ambassador from the United States to Japan; Sir James Colquhoun Irvine, principal and vice-chancellor of the University of St. Andrews, Scotland; and Dr. Louis Martin, director of the Pasteur Institute, Paris, were among the notable figures participating in ceremonies honouring the Philadelphia printer who became a world-famed man of science and statesman.

The annual award of medals by the Franklin Institute; the conferring of degrees by the University of Pennsylvania, which is the outgrowth of an academy founded by Franklin; the participation by thousands of school children in massed choruses and bands and in a colourful "Young Philadelphia Parade"; and a pilgrimage to the new Franklin shrine by representatives of to-day's printing industry were prominent features of the dedication.

"From this time forward the Benjamin Franklin Memorial will be his [Benjamin Franklin's] permanent home, and I extend a hearty invitation to all people everywhere to visit him and make him their friend," said Mr. Pepper in a dedicatory address.

The new 'home' of the eighteenth century sage who revealed the identity of lightning and electricity and made important investigations and discoveries in many other fields of natural philosophy, is fittingly located in a classic structure dedicated to scientific progress. In the spacious building on Benjamin Franklin Parkway in Philadelphia, the Franklin Institute, founded in 1824 and active in the promotion of science and the mechanic arts, maintains its "Wonderland of Science" Museum, where more than 4,000 action exhibits reveal the part played by science in everyday life; and its Fels Planetarium, noted for its reproductions of the heavens. The spiritual centre of this building, and a public shrine to the memory of the great statesman and natural philosopher, is the new Franklin Memorial. There, in a lofty memorial room inspired by the Pantheon in Rome, rises the heroic statue; a seated figure in white Seravezza marble, more than twice life-size. Upon its huge pedestal of rose aurora marble from Portugal, it extends to a height of 18 feet above the floor. The sculptor, James Earle Fraser, whose

notable statues, groups and relief portraits grace many parks and public buildings throughout the United States and Canada, began work on the Franklin statue five years ago, and has described his own conception in the following words:

"A massive figure, tranquil in body, with latent power in his hands, but with an inquisitive expression in the movement of his head and the alertness of his eyes, ready to turn the full force of his keen mind on any problem that concerned life."

In a manner that would have aroused the keen interest of her famous ancestor, ten-year-old Miss Louisa Johnston Castle, of Wilmington, Delaware, a lineal descendant of Franklin, unveiled the statue by turning a searchlight upon a photo-electric cell.

In the three-day programme, Franklin was commemorated as "Patriot and Man", as "Philosopher and Educator", and as "Printer and Business Man". Special exhibits depicting the advance of science from Franklin's day to the present time, on display in the Wonderland of Science Museum, vied with lectures by noted men of science and educators of two continents in the tribute to the great American's scientific achievements. Developments in electricity were shown, from an electrical machine which Franklin once owned to a modern half-million volt surge generator producing man-made lightning. Progress in printing, 'Poor Richard's' own craft, was demonstrated from a hand-press used in Franklin's original printing shop to modern presses that print in four colours. Paper-making was performed by hand just as it was in Franklin's day, and the entire modern process from pulp to finished paper also was demonstrated on a miniature scale-model Fourdrinier paper-making machine. A replica of the "Pennsylvanian Fireplace", one of Franklin's outstanding inventions, was shown in contrast with an exhibition of the development within the last twenty years in automatic oil-heating equipment for home use.

In a notable series of lectures on pure science, given at the Franklin Institute on May 20, Sir James C. Irvine spoke on "Benjamin Franklin in Saint Andrews, 1759", Dr. C. E. K. Mees, director of the Research Laboratory of the Eastman Kodak Company, Rochester, N. Y., who is a native of Wellingborough, England, and was educated at Harrogate and St. Dunstan's, on "Photography and the Advance of Pure Science"; Dr. Gilbert N. Lewis, dean of the College of Chemistry, University of California, Berkeley, Calif., on "Old and New Views of Acids"; Dr. George D. Birkoff, the distinguished mathematician of Harvard University, Cambridge, Mass., on "Electricity as a Fluid"; Dr. Forest Ray Moulton, permanent secretary of the American Association for the Advancement of Science, Washington, D.C., on "The Influence of Astronomy on Science"; Dr. Arthur L. Day, formerly director of the Geophysical Laboratory, Carnegie Institution, Washington, D.C., on "Volcanoes, Geysers and Hot Springs"; Dr. Louis Martin, director of the Pasteur Institute, Paris, on "L'Hospitalisation des Maladies Contagieuses"; Dr. Thomas H. Morgan, of the California Institute of Technology, Pasadena, Calif., on "Human Heredity and Modern Genetics"; and Dr. Merritt L. Fernald, of Harvard University, on "Must All Rare Plants Suffer the Fate of *Franklinia*?"

Lectures on applied science were given at the Franklin Institute on the following day by Dr. Willis R. Whitney, vice-president in charge of research, General Electric Company, Schenectady, N.Y., who spoke on "It's Called Electricity"; Dr. Abel Wolman, professor of sanitary engineering, Johns Hopkins University, Baltimore, Md., on "The Trend of Civil Engineering since Benjamin Franklin"; and Dr. Harvey N. Davis, president of the Stevens Institute of Technology, Hoboken, N.J., on "Engineering and Health".

Delegates from leading learned societies and educational institutions of the United States and Europe were welcomed at the dedication ceremony by Philip C. Staples, president, and Dr. Henry Butler Allen, secretary and director of the Franklin Institute. Sir Albert Seward, delegate from the Royal Society of London, was in attendance with Lady Seward, and presented to the Institute a photostat copy of the certificate making Franklin a fellow of the Royal Society in 1756.

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## Artificial Production of Snow Crystals

IN NATURE of August 28, 1937, p. 345, an account was given by G. Seligman of experiments carried out at the University of Hokkaido by Prof. U. Nakaya. Since that article was written, Prof. Nakaya has made considerable progress towards his aim to produce, artificially and under strictly controllable conditions, the great variety of natural snow crystals*. He assumes that we can trace the entire history of the fallen snow crystal from observations of its size, form and habit, and infer the physical state of

* "Preliminary Experiments on the Artificial Production of Snow Crystals". By Ukitirô Nakaya, Isonosuke Satô and Yatarô Sekido. "Further Experiments on the Artificial Production of Snow Crystals". By Ukitirô Nakaya, Yasuaki Toda and Syûzô Maruyama. (*J. Fac. Sci.*, Hokkaido Univ., Series II, Vol. II, No. 1; 1938.)

its environment during condensation and during its subsequent movements through the atmosphere, if we can establish the laws governing its development.

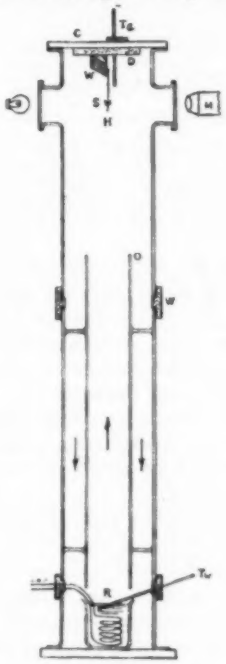


Fig. 1.
APPARATUS FOR THE ARTIFICIAL PRODUCTION OF SNOW CRYSTALS.

Nakaya's experiments were carried out in a cold chamber the temperature of which could be lowered to −50°. The apparatus employed for the production of artificial snow crystals is shown in Fig. 1. By heating the water in the dish *R* with an electric coil, a flow of saturated, warm air is produced in the inner of two concentric cylinders. When the air reaches the point *O* it is chilled by the walls of the cooled outer cylinder. The rabbit hair *H* serves as a nucleus for the condensation of the now supersaturated vapour and the growing crystal *S* can be observed through the telescope *M*. The temperature at the water surface ($T_w$) and that near the crystal ($T_a$) are recorded. The apparatus has the advantages that both the temperature and the degree of supersaturation can be varied within wide limits, and that a nucleus for the condensation is provided which allows unhampered growth of the crystal in all directions and yet keeps it stationary in front of the telescope. Fig. 2*a* shows a snow crystal grown in this apparatus, still attached to the rabbit hair. It is seen from comparison with the natural snow crystals reproduced in Fig. 2*b* that the artificial product resembles the natural one in regularity as well as in degree of complexity.

Nakaya divides the growth of the snow crystal into two stages: the formation of the germ and its subsequent development. He finds that the type of the former greatly influences the final shape of the crystal, however radically he alters $T_w$ and $T_a$ during the second stage. Therefore, the first object of his investigations was an enumeration of possible types of germs and a study of the conditions for their formation. Schematic drawings of his twelve types of early stage snow crystals are shown in Fig. 3, and a record of their history is given in the table which follows. Evidently temperatures above −20° C., with a relatively copious supply of water vapour, produce complex shapes such as dendrites or "assemblages of sectors", the latter probably caused by multiple twinning. The formation of simpler types appears to be favoured by lower temperatures, while the perfection of the crystals seems to depend primarily on the regularity of the temperature gradient. Rapid chilling of highly supersaturated vapour produces clusters of irregular fragments (Type 2) or even frozen droplets.

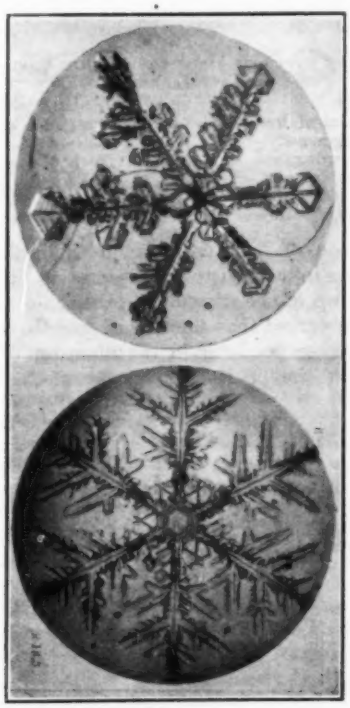


Fig. 2.
SNOW CRYSTALS. (*a*) ARTIFICIAL CRYSTAL. ×APPROX. 11. (*b*) NATURAL CRYSTAL. ×APPROX. 12.

The actual degree of supersaturation in the neighbourhood of the rabbit hair was not measured in any of Nakaya's experiments, but a

supersaturation ratio ($s$) is given, defined as the ratio of the saturation vapour pressure at the water surface ($T_w$) to that near the crystal ($T_a$). It was found, however, that experiments with identical supersaturation ratio did not always produce the same results, since uncontrollable factors such as

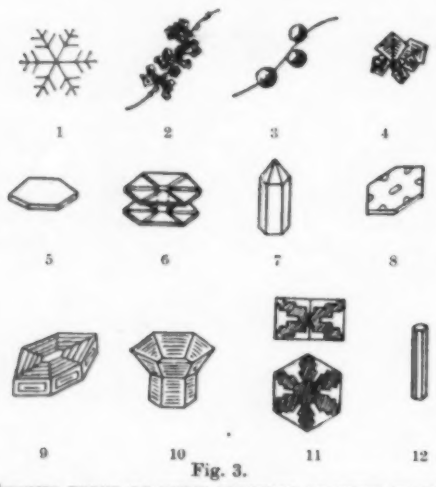


Fig. 3.

TWELVE TYPES OF SNOW CRYSTALS IN THEIR EARLY STAGES:

1. Dendrite.
2. Clusters of irregular fragments.
3. Frozen droplets.
4. Assemblages of sectors.
5. Thin hexagonal plate.
6. Cylinder with end plates.
7. Prismatic pyramid.
8. Hexagonal plate with design.
9. Thick hexagonal plate.
10. Cup crystal.
11. Prismatic skeleton.
12. Prismatic needle.

deposition of hoar crystals on the walls of the cylinders influenced the concentration of moisture at the top of the apparatus. On the other hand, it was observed that the rate of growth, defined as the increase per hour in the diameter of a circle enclosing the crystal, is characteristic for each type and can serve as a qualitative measure of the degree of supersaturation. However, absolute measurements of the supersaturation values in terms of water content per unit volume seem highly desirable in view of the possible applications of Nakaya's researches to meteorology.

During the second stage of crystal development, the rates of growth have been measured with considerable accuracy. Some of the results are given below:

| | |
|---|---|
| Fern-like dendritic branches of great complexity | 10–3 mm. per hr. |
| More massive hexagonal plates with broad extensions at the corners | 1·3 mm. per hr. |
| Hexagonal plates and assemblages of sectors of plates | 0·7 mm. per hr. |
| Massive prisms, pyramids, prismatic needles* and "spirals" | 0·5 mm. per hr. |

* In his article in NATURE, Mr. Seligman expressed his surprise that Nakaya observed needles and prisms at different ends of the temperature scale in snowfalls, the needles occurring under warm and the prisms under extremely cold conditions. It may be suggested that these needles are not prismatic, but consist of branches of dendrites which have broken off from their base and lost the details of their structure by melting.

The spirals are a peculiar phenomenon which has been observed in crevasse hoar by Seligman and others. They look like ordinary hexagonal prisms, but on closer inspection their cross-section perpendicular to the hexagonal axis is seen to resemble a 'hexagonal clock-spring'. Slow growth of the germ is essential for this type. In Nature, it develops only under calm conditions with a small temperature gradient providing for a slow rate of sublimation.

Nakaya also reports that rhombohedral (β-ice) and cubic ice crystals were produced at temperatures of about −30° C. and low saturations. In view of the fact that neither X-rays nor polarized light were employed for their identification, these results must be regarded as rather uncertain. Finally, snow crystals were grown from heavy water. It is interesting to note that their external structure was very similar to that of snow crystals grown from ordinary water.

Nakaya has taken many thousands of photomicrographs of artificial snow crystals. By his elaborate researches he has created an invaluable new implement for the meteorologist and provided the research worker on snow with a most interesting collection of new facts. It is to be hoped that by a more systematic presentation of his results, by improvement of his nomenclature along more accepted crystallographic lines and by quantitative measurement of his supersaturation values, he will justify the expectations of those who have followed his earlier work.

MAX PERUTZ.

| Type No. | Type | $T_w$ | | | $T_a$ | | | $t$ (in hours) |
|---|---|---|---|---|---|---|---|---|
| | | Initial | Middle | Final | Initial | Middle | Final | |
| 1 | Small dendrite | + 5° C. | + 10° C. | + 15° C. | − 19° C. | − 17° C. | − 18° C. | 0·5 |
| 2 | Clusters of irregular fragments | + 3 | + 35 | + 20 | − 20 | − 13 | − 15 | 0·5 |
| 3 | Frozen droplets | + 6 | + 46 | + 25 | − 22 | − 10 | − 12 | 0·5 |
| 4 | Assemblages of sectors | + 10 | + 16 | + 19 | − 15 | − 13 | − 12 | 1·5 |
| 5 | Thin hexagonal plate | + 6 | + 10 | + 12 | − 24 | − 22 | − 16 | 2 |
| 6 | Cylinder with end plates | 0 | + 8 | + 20 | − 20 | − 20 | − 14 | 5·5 |
| 7 | Prismatic pyramid | + 3 | + 5 | + 10 | − 29 | − 27 | − 25 | 7 |
| 8 | Hexagonal plate with design | + 4 | + 4·5 | + 4·5 | − 26 | − 27 | − 28 | 15 |
| 9 | Thick hexagonal plate | + 2 | + 4 | + 1 | − 38 | − 36 | − 39 | 18 |
| 10 | Cup crystal | + 5 | + 4·5 | + 4 | − 21 | − 21 | − 19 | 17 |
| 11 | Prismatic skeleton | + 6 | + 8 | + 10 | − 22 | − 22 | − 20 | 20 |
| 12 | Prismatic needle | + 4 | + 4 | + 4 | − 30 | − 30 | − 28 | 25 |

# Obituary Notice

## Prof. A. E. Boycott, F.R.S.

ARTHUR EDWIN BOYCOTT, whose death occurred on May 12 last, was an eminent pathologist. He was also a distinguished naturalist. He was listened to with the same respectful attention by an assembly of malacologists as by one of pathologists. His wide knowledge of biology is notable in his writings and gave a special character to his teaching of pathology.

Boycott was born at Hereford in 1877 and educated at the Cathedral School. In 1894 he entered Oriel College, Oxford, with an open classical scholarship. He gained a first class in Classical Moderations and then turned to medicine, pursuing his preliminary scientific studies in the Natural Science Schools. He studied physiology under Burdon Sanderson, Gotch, Mann and Haldane, and pathology under Ritchie. He was particularly influenced by the last two, both of whom became life-long friends. He graduated with first-class honours in natural science and was elected to a Fraser Research Scholarship. In October 1899 he went to St. Thomas's Hospital, where he completed his medical course and graduated M.B.(Oxon.) in 1902.

Boycott wanted to devote his life to investigation rather than to practice of the healing art, and in the following year the first step towards satisfying this ambition was achieved by his appointment to a subsidiary lectureship in pathology at Guy's Hospital and election to a fellowship at Brasenose. In 1904 he accepted the position of assistant bacteriologist at the Lister Institute. Three years later he was recalled to Guy's to become the first whole-time lecturer in pathology. In 1912 the chair of pathology at Manchester became vacant and Boycott was appointed. He liked the University but disliked the climate of Manchester, and in 1915 he returned to London to occupy the Graham chair of pathology at University College, which carried with it the supervision of the research laboratory of the new clinical school. Here he remained until 1935, when continued ill-health obliged him to resign and retire to the country.

Boycott's scientific activities covered a wide range. His individual researches and those conducted in collaboration with various colleagues and pupils on physiological, pathological and zoological subjects are contained in some eighty papers, and it is impossible to do more than indicate the scope of some of the more important in a short article.

The earliest work published by Boycott, on the effect of cold on the conductivity of nerves in the frog and rabbit respectively, was done under Gotch. The publication of these two papers stamped him as a capable investigator, but he did not follow up this line of inquiry after leaving Oxford.

In 1903 the co-operation of Boycott was enlisted by his former teacher, John Haldane, in an investigation of the anæmia of Cornish miners. Haldane had discovered that the trouble was due to ankylostomiasis, a disease hitherto unrecognized in Britain. Together they embarked upon a comprehensive research into this disease which, continued by Boycott, lasted some three years. This investigation left not much unknown about its pathology, its epidemiology in mines in Great Britain, and the life-history of the parasite.

Whilst at the Lister Institute, Boycott made a useful contribution to the immunology of typhoid and paratyphoid fevers and also a study of the seasonal distribution of the diphtheria bacillus and Hoffmann's pseudo-diphtheria bacillus in the throats of a London population, but he was mainly occupied with Haldane during this period with an extensive investigation of the effects of compressed and rarified air upon the animal body. That on increased atmospheric pressures, in which Damant also collaborated, was called forth in order to explain and if possible to find means to prevent, the often fatal accidents to which caisson-workers and deep-sea divers are liable.

Much valuable information was obtained about the pathology of compressed air illness. It was shown to be due to the formation of bubbles of nitrogen in the tissues during the period of decompression, if this were too hastily brought about. The relationship between this occurrence to both the amount and duration of the compression and to the rate of decompression was determined experimentally. The correctness of Haldane's prediction that if decompression were carried out by stages instead of continuously, the time required for safety could be greatly reduced, was also demonstrated, and their experiments were sufficiently quantitative and numerous to permit time-tables for decompressing divers by stages to be drawn up which afforded a margin of safety. These are now universally employed. Incidentally, the working-time under pressure and the depth attainable by divers has thereby been materially increased. The investigation by Haldane and Boycott of the regulation of respiration at reduced atmospheric pressure and of the pathology of mountain sickness, in which Ogier Ward was a partner, was also a fine piece of work. The results furnished a completer understanding of the causes of the respiratory embarrassment when the tension of oxygen is reduced by rarefication of the air and of the body's methods of acclimatization to high altitudes.

Boycott was engaged in yet another research with Haldane on the physiological adaptation of man to an environment of high temperature and great humidity, in which the limitations of adjustment were ascertained both when idle and performing increasing amounts of work. They published only one short paper together on this subject; the bulk of the observations for which Boycott was responsible were incorporated in reports and lectures by Haldane.

The contribution to the above three researches made by Boycott has been somewhat obscured by

the fame of the senior partner. Haldane originated them and doubtless had much say in the planning of the experiments, but Boycott had most to do with carrying them out.

Boycott's scientific output during the three years spent at the Lister Institute was very considerable. The partnership with Haldane was a delight, and mutually advantageous. Boycott was young and vigorous, and had neither teaching nor administrative duties. Henceforth, he occupied professorial posts; and responsibility for the pathology of great hospitals, teaching, the direction of the work of others and the editorship of the principal pathological journal in Britain greatly reduced the time left for individual researches. Nevertheless, he continued to be an active experimenter.

From 1908 onwards a great part of Boycott's researches, in most of which various colleagues collaborated, was concerned with some aspect of blood as a tissue. Whilst a student at Oxford, he had become an adept with the method of Haldane and Lorrain Smith for determining the total volume of blood in the body. Years afterwards, he and Douglas critically re-examined the method and showed that, with minor improvements in technique, reliable results could be obtained, and that in skilled hands it was free from danger. Boycott afterwards made good use of this powerful engine of research in investigating various types of anæmia and polycythemia occurring in patients and experimentally produced in animals. These have led to a clearer conception of the pathological features of these diseases.

A subject which especially aroused Boycott's interest and to the investigation of which he returned again and again was the power possessed by the body to restore the volume and composition of the blood to normal after disturbance by hæmorrhage or transfusion. Some of his best work is that designed to throw light on the way these reparative adjustments are brought about. He found that the rate of restoration was increased by education and that the destruction of superabundant elements after a transfusion only occurred if they were not wanted. He discovered a number of interesting facts and, although complete understanding of how such adjustments are brought about is still far off, these facts and the emphasis he laid upon them are highly important.

Another experimental inquiry which was begun at Guy's with Ryffel and continued at Manchester with Douglas as partner had for its purpose the study of the part played by the kidney in the regulation of the volume and composition of the blood. With this object, Boycott and his colleague studied the effects of withdrawal and addition of fluids and the action of diuretics on normal animals and others in which the secretory tubules of the kidney had been put out of action by poisoning with salts of uranium. Adjustment was found to be much delayed in the latter. The interpretation of some of their experimental results was not clear at the time, but later work by others has afforded an explanation of some of them.

Boycott was distinguished from other prominent hæmatologists in that he was interested in blood as a whole and not more particularly in its cellular constituents. His discoveries constituted an important contribution from several angles to the physiology and pathology of blood. Many of them were incorporated into the excellent article on the subject written for Pembrey and Ritchie's "Text Book of General Pathology" in 1913. That is still good reading.

During the earlier years of the Great War, Boycott was occupied in doing the work of younger colleagues who had joined the army. He served upon various Government committees for which his special knowledge and sound judgment rendered him suitable. It was an unhappy time as he found himself out of sympathy with the attitude of many of his friends towards the conflict. In 1917 he joined the R.A.M.C. and was associated with Barcroft and other physiologists at the experimental station at Porton in the investigation of the physiological action of poisonous gases used or likely to be used by the combatants. In this work he rendered valuable service, and its scientific interest mitigated the misery he endured in the contemplation of the purposes to which the materials were being put.

As assistant editor of the *Journal of Pathology* for fifteen, and editor for twelve years, Boycott rendered a great service to pathology in Great Britain. He was peculiarly well fitted for the work by his wide knowledge, critical judgment and keen appreciation of orderly presentation and literary form. It was a labour of love and he devoted much of his time to the work. He was a helpful editor, and many an author has to thank him for reducing his manuscript to readable shape, a process which sometimes meant re-writing it. The debt which the Pathological Society owes to Boycott will not easily be forgotten. Under his editorship, its journal increased in prestige as well as in size.

The briefest account of Boycott's scientific work would be inadequate without reference to his observations on snails. As a boy, he was fond of snails and catalogued those of Herefordshire. The attachment lasted through life, and the last scientific papers he published were two memoirs on the habitats of the land and freshwater Mollusca in Britain. These are not mere catalogues of distribution; they are full of information about the habits and life-history of these creatures in so far as it appears to have determined their distribution. A zoologist friend tells me they are regarded as classics, and that they contain more information to the page than anything he has read.

Boycott is also responsible for a serious research in genetics. It began some twenty years ago when his attention was directed to the occurrence of some left-handed staircases in the shells of a common water snail, *Limnæus peregra*, in a pond in Yorkshire, and is still going on. Usually dextral, the nature of its spiral depends upon the asymmetry of its soft parts. Boycott perceived that he had encountered first-rate material for genetic research, the character, sinistrality, being readily discernible and no intermediate condition possible. Furthermore, *Limnæus peregra*,

although preferring cross-fertilization, could readily be induced to propagate parthenogenetically. He forthwith began to breed snails from selected parents or parent and to determine the proportion of right- and left-handed ones in successive generations. As the generations increased, and notwithstanding the enlistment of collaborators, the labour became almost overwhelming. A few years ago the total progeny exceeded a million! The results of this prodigious experiment were communicated from time to time in appropriate journals and in 1930 gathered together in a memoir published by the Royal Society in its *Philosophical Transactions*. Briefly stated, sinistrality was found to be a Mendelian recessive character complicated by a tendency towards dextral mutations.

The transfer of so much of Boycott's energy to zoology was regretted by his brother pathologists, and the fact that his love for biology was responsible for his wide outlook on pathology did not appease their jealousy.

As well as being a fine experimenter, Boycott was equally good at contemplation and an artist in expression. Of recent years he gave several stimulating addresses which have more than ephemeral value. In these essays he found an opportunity for displaying the rare combination of knowledge, philosophical insight and literary charm which he possessed. He used them to review knowledge of some subject in pathology and its implications, or for an expression of his views on the proper attitude towards the study of pathology. His conception of the content of pathology was different from that of most. He defined it as the study of how organisms resist and repair injury. In the post-mortem room and the museum are recorded only the failures on which, he thought, attention had been too much concentrated. The phenomena of protection and repair certainly represent the more cheerful side of pathology, and were particularly attractive to Boycott because of the evidence of purpose apparent in them.

Boycott was one of those who are said to pursue knowledge for its own sake, which means that he was curious and found sufficient satisfaction in making experiments with a sporting chance that he might have imagined the right question to ask and planned the appropriate experiment to obtain an answer. Whether the knowledge to be gained was likely to be of any immediate service, ought, he maintained, to be immaterial. The exclusion of utility as a righteous motive for embarking upon an investigation was, I believe, largely a reaction to the commercialism which he feared was trespassing upon the sanctity of scientific laboratories.

He was a charming companion and a staunch friend always ready with help and sympathy in time of trouble. He held strong views on most subjects and refused to compromise even on small matters when he imagined a principle was involved, but as he could be depended upon to be on the side of the angels, a measure of intransigence was unimportant.

C. J. M.

# News and Views

## Long-Range Weather Forecasts

In a series of questions asked by Mr. S. F. Markham in the House of Commons on June 22, relating to the stations and research staff of the Meteorological Office, one referred to weather forecasts for a fortnight or longer, now being published in Great Britain and in Germany, and suggested that the Office might supplement its present forecasts by such long-range predictions. In his reply, the Secretary of State for Air said: "I am aware of the long-range weather forecasts being attempted by various methods in many different countries. These efforts are being carefully studied by the Meteorological Office, but so far none of the methods has attained the accuracy which would justify the issue of such forecasts in this country". This reply may not satisfy the public, which fails entirely to distinguish between weather forecasts based upon established scientific principles and observations, from prophecies of an astrological nature or any system which has not been submitted to a scientific society for disinterested consideration. Whatever is known about long-range weather forecasting is understood by our Meteorological Office, and if any practical end could be served by applying such knowledge, advantage would certainly be taken of the opportunity. In science it is not enough for an observer to satisfy himself that his investigations prove a principle, but the evidence has to convince other scientific workers before the principle is accepted. Until this has been done, any long-range weather forecasts published in the daily Press, whatever accuracy is claimed for them, are altogether unworthy of being placed in the same category as the daily forecasts at present issued.

## Air Survey and Archæology in Germany

Early in the current year, Mr. O. G. S. Crawford, archæological officer of the Ordnance Survey, received an official invitation from Germany to organize an exhibition of the results of archæological air photography in Great Britain, and to deliver a lecture on the subject in March. An account of the exhibition is contributed by Mr. Crawford to *Antiquity* of June 1938. With the consent of the Ordnance Survey, about forty enlarged, and about one hundred small photographs were shown, together with a selection from the remarkable collection of photographs taken by Major Allen, which Mr. Crawford remarks, "so brilliantly illustrates the archæological value of air photography". The exhibition was held in what was the Upper House of the former Prussian Parliament, the arrangements being made by the Lilienthal-

gesellschaft, and invitations sent to pilots of the German Air Force and to the leading German archæologists. The exhibition also included a selection of photographs taken by German pilots, who are now keenly interested in the subject and have begun to collaborate with the archæologists. It would appear that the exhibition, which lasted for two days, and of which the proceedings were devoted to the discussion of technical problems, was a great success. The meeting closed with a lecture by Mr. Crawford, when Dr. Buttler and Ministerialrat Ewald were present and also spoke. To this lecture members of the public were admitted, and several hundreds of people were present. An account of the proceedings is to be published by Lufthansa as an illustrated monograph.

AT the conclusion of the meeting, Mr. Crawford, in proceeding by air to Athens on business connected with the Greek portion of the map of the Roman Empire, was able to make a number of interesting observations. On his way to Berlin he had observed traces of an early, probably medieval, field system between Brussels and Cologne, of which he had also detected indications on some of the German air photographs. Similar evidence was obtained in the soil marks—long white bands forming a pattern—between Budapest and Belgrade. These, in his opinion, are the vestiges of an ancient field system. Whatever their age and original intent, they seem to have no relation to the existing field system, which itself has the appearance of considerable antiquity. To decide the point, a large area should be photographed from the air in suitable conditions, and a mosaic constructed, with subsequent excavation at selected points to decide the matter. In addition, Mr. Crawford observed three Roman camps on arable land, and the course of several defensive dykes, some of post-Roman date, which though long known to exist, have never been properly investigated. Mr. Crawford concludes by pointing out that this region is one of the best fields in Europe for combined field-work from the air and on the ground, and expresses the hope that our archæological colleagues of Yugoslavia will follow the example of Germany and inaugurate work in this unexplored and most promising field.

### Excavations in the Egyptian Sudan, 1937-8

THE annual exhibition of the Egypt Exploration Society opened at the Society's rooms, 2 Hinde Street, Manchester Square, London, W.1, on June 23. It will remain open daily until July 14. In 1937–38 excavation was continued on the site of the fortress-town of Sesebi on the banks of the Nile, about one hundred and eighty miles south of Wady Halfa. Shortly before the close of the season, the site had been completely excavated, and the expedition spent twelve days in a preliminary examination of the new concession at Amarah West, about sixty miles north of Sesebi, where it is hoped to begin systematic excavation in 1938–39. Although the number of finds at Sesebi this year was small, they are of no little archæological and historical interest. Faience objects bearing the name of Amenhotep IV from intact foundation deposits under the walls of the town indicate that the town, as well as the temple, was built by this king about 1480 B.C., before he adopted Aten worship and changed his name to Akhenaten. A sandstone block bearing a representation of the god Amun, or of Amenhotep wearing the plumes of the god, which was found built upside down in the sanctuary of the temple erected by Seti I, is of no less interest as an example of the art of the period before Akhenaten changed the canons of art, as well as his religion. Both these finds are of importance as belonging to a period from which material is scanty. A black granite fragment showing a daughter of the king, embraced by a sister or a parent, is the only clearly Amarna piece that has been discovered at Sesebi. An interesting sandstone bust of a dead man, swathed in mummy bands, which when in position would appear to be bursting from the ground, is a rare example of a symbol of resurrection.

THE most interesting and significant fact which emerges from the excavation at Sesebi is that though built in the conventional form of a fortress-town, it had no moat, no special defences for its gates, and there was, apparently, no strategic reason for its position. It could not withstand a prolonged attack, whereas other previously known fortress towns of this region command strategic points on the Sudanese trade routes, have deep moats, and are strongly fortified. Hence it would appear that by the time Sesebi was built, the political and economic dominance of the Egyptian Empire in the Sudan was sufficiently firmly established to make the establishment of fortress-towns like Sesebi as anything more than trade and religious centres superfluous—an important piece of evidence of the organization of the Egyptian Empire in the Eighteenth and Nineteenth Dynasties. At Amarah West there has come to light in the preliminary tests evidence which suggests that there may have been a late Eighteenth Dynasty occupation as well as that of the Nineteenth, of which the remains, in the form of temple and town, crown the mound of the site under a deposit of some six feet of blown sand. This deposit has kept the walls in an excellent state of preservation, to a height of six feet, and holds out promise of inscriptional material, and possibly statuary, in the temple. An interesting find, of which it is hoped more will be heard in future excavation, is an axe-celt and two agate arrow-heads, which appear to afford evidence here of a new and little-known Sudanese culture.

### Exhibition of History of Handwriting

AN exhibition now open at the London County Council's Horniman Museum, Forest Hill, London, S.E., illustrates the development of handwriting and its different systems. It begins with pictographic and hieroglyphic forms, and shows how the conventionalized breaking down of the picture produced the alphabetic systems, tracing the development through early Phœnician to Greek and Latin. The development of Babylonian cuneiform is also shown, demonstrating how its character was determined by the

nature of the material used for record, the clay tablet, which necessitated the use of a stylus in the form of a stamp lending itself to ready and relatively rapid duplication. Among later developments shown are the Lombardic, Merovingian, Visigothic, Anglo-Saxon and Irish 'hands', as well as the still later and contrasting forms of Italian and English Secretary—Shakespeare's signature is an example of the latter—between which rivalry lasted in England until well into the seventeenth century. The exhibits include illuminated manuscripts, samplers and tally sticks, facsimiles of important historical documents, such as Magna Charta, and of the signatures of prominent personages, ancient and modern. The exhibition will remain open until August 31.

### "Druid" Temple near Glasgow

A LARGE part of this temple on the Anniesland-Duntocher Boulevard at Glasgow, near Clydebank and Kilbowie, has now been re-constructed. New wood has been substituted for the decayed and carbonized original timber. The circular area of the sanctuary appears to have a diameter of 245 feet, bounded probably by a ring of nineteen large, white, hard sandstone pillars equidistantly set and each about 8 feet in height. Numerous graves have been found under the floor or old surface. As indicated by the pottery and other relics, the burials near the centre are of the Stone Age. The outer graves belong to later prehistoric periods, the various phases of the Bronze Age. The temple was evidently a favourite place for interments for a very long period. Four graves, very close to the centre of the temple, have just been opened and may be inspected during the next few days, after which they will be again covered over. These four graves are all built of large stones and in two cases contain much decayed timber and wicker-work. The topmost stones in several cases bear curious devices belonging to the class of carvings known as 'cups-and-rings'. Stone implements were found in some of the tombs. The largest of the four tombs has a depth of 8 feet. The walling of its shaft contains about fifty stones. The excavation of this site has been carried out by Mr. Ludovic Mann, 183 West George Street, Glasgow, C.2.

### New Pathological Institute at Guy's

THE new Pathological Institute of Guy's Hospital Medical School was opened on June 23, by the chancellor of the University of London, the Earl of Athlone, supported by the vice-chancellor, Sir Robert Pickard, and the principal, Dr. H. L. Eason. The Governing Body was represented by Viscount Goschen, Viscount Nuffield, Lord Cunliffe, and Mr. R. C. Nesbitt. The building is a large eight-story fire-proof extension behind the present anatomy, physiology and chemistry departments on a site formerly occupied by Spur Inn Yard, the outbuildings of a famous medieval Southwark inn. It combines in a single unit the former scattered laboratories of pathology, clinical chemistry and bacteriology, originally housed in old adapted warehouses. Ample laboratory accommodation is also provided for the Clinical Research Unit recently established by the Medical Research Council at Guy's and for the Guy's Hospital clinical research fellow. The connexion between the Medical School and the Hospital will be fully maintained by the provision of extensive accommodation for the hospital routine investigations. Thirty fully equipped laboratories have been provided for original investigations. The total cost of the building and equipment has been between £85,000 and £90,000, of which £10,000 has been contributed in the form of a capital grant by the University Court. There remains a debt of some £40,000, which, until paid off, will prevent the full realization of the objects for which the building has been provided.

### The Newcomen Society

FAVOURED with beautiful weather, the Newcomen Society held its summer meeting in the Lake District on June 15–18. The programme was a very full one and included visits to mines, iron furnaces, snuff mills, an organ building works, a bobbin mill, a paper mill and Kendal Museum. At Lindale-in-Cartmel a short stay was made to inspect the cast-iron obelisk to the memory of the great iron-master John Wilkinson, and in a small engineering shop near Kendal the members found a very early iron planing machine, which it is to be hoped will one day find a place in a museum, instead of passing to the scrap-heap. With its many streams, the Lake District abounds in turbines and water-wheels, several of which are of considerable interest. Not the least interesting items in the programme were the visits to the Greenside Lead Mines, Glenridding, which, after being worked for two hundred years, are being modernized, and to the old copper mine at Goldscope, a short way from Keswick, which was worked in the days of Queen Elizabeth by the Society for the Mines Royal. At a meeting on the evening of June 15, a paper was read on the works at Goldscope, by Mr. Rhys Jenkins, who has traced the immigration into the district of some 150–200 German miners from the Tyrol. The principal figure in the venture was Daniel Hochstether, while much of the capital was provided by the Augsburg firm, Haug and Co., the account books of which are still preserved.

### The Dartmoor Catchments

AMONG the papers presented at the annual general meeting of the British Waterworks Association on June 22 were two containing certain features of general scientific interest. The paper on "The Dartmoor Catchments" by Mr. Hansford Worth gave a detailed description of the physical features of the great granite highland occupying an area of 248 square miles in the county of Devon. He divided it into three districts, the eastern, the northern and the southern, according to differences of elevation. He explained how the weathering of the granite results in a product, locally known as 'Growan'. Owing to the softening of the rock and the loss of its coherence as the result of the decay of the felspars, there is evolved a sandy, and not a clayey mass, which, near the surface, shows the movement known as 'hill-creep', an excellent example of which is to be seen

on the roadside near the Sheepstor Dam. The porosity of the growan affords ample storage for rainfall, which in Devon is high, ranging up to more than 80 inches per annum. The monthly distribution is remarkably regular, when long periods are averaged, but wholly irregular in any one year. Mr. Worth went on to analyse the run-off resulting from rainfall and found that there is a drought regime for every stream, and that following any day in which there has been no actual flood, it is possible from the ascertained flow on that day accurately to predict the flow of the stream for the next 24 hours, in the absence of rain. Instances were given of several notable floods and their havoc.

### Protection of Underground Water Supplies

THE second paper, on "The Protection of Underground Sources of Water Supply", by Mr. Edgar Morton, had special reference to the Town and Country Planning Acts, and was directed to two aspects of protection, namely, protection of an existing source of public supply against exploitation for industrial purposes, and, secondly, protection against the possibility of pollution from external sources. As regards the former, pointing out that in most private Acts involving underground waterworks, there is a clause for the protection of existing sources of supply—wells, boreholes and springs—within a specified radius of the authorized works, Mr. Norton stated that within recent years there has been a tendency to extend such protection to include streams, ponds and pools, in so far as they are fed by springs which originate within the protected zone, although the user of such streams, ponds or pools may be outside the zone. A serious aspect of the inadequacy of existing legislation is that, while Parliament imposes upon the promoters seeking new sources of supply for public benefit at the least possible cost, restrictions respecting their boreholes, no reciprocal protection has until recently been given to the promoters against the exploitation of their water resources by industrial enterprise. As regards protection against pollution, various ways were enumerated by which it could be obtained in limestone and chalk areas and in sandstone areas respectively, with instances of specific cases.

### The Argyll National Forest Park

REFERENCE to the Argyll National Forest Park was made in NATURE of October 16, 1937, p. 692; and now a small brochure with the title "The Argyll National Forest Park Guide" has recently been issued by the Forestry Commissioners. The Guide has been edited by Prof. John Walton, regius professor of botany in the University of Glasgow, and has a foreword by Sir Roy Robinson, chairman of the Forestry Commission. The National Park consists of large stretches of mountain and moorland lying to the west of Loch Long. It is divided into two main areas. The northern consists of Ardgartan and Ardgoil and forms a wedge of mountains between Loch Goil and Loch Long. The southern area is bounded on the east by Loch Long and Loch Goil. The two areas are built up of a group of estates, the Ardgoil Estate having been presented to the Corporation of the City of Glasgow by Mr. Cameron Corbett, the others having been acquired by the Forestry Commission, which has since afforested large areas. The total area of the estates amounts to 54,000 acres about 19,000 of which are reserved for afforestation, leaving approximately 35,000 acres available for use as a National Park. At the southern end of this Park are situated Benmore House and its finely laid-out gardens and shrubberies which were presented to the Forestry Commissioners by Mr. Harry G. Younger. This Park presents interests for every taste and the Guide deals with its history (Prof. J. D. Mackie), geological structure (Dr. J. G. C. Anderson), vegetation (Prof. J. Walton), forests and plantations (Mr. J. M. Murray, assistant commissioner for Scotland), and fauna (Prof. E. Hindle), all, with the exception of Mr. Murray, on the staff of the University of Glasgow.

### British Museum (Natural History): Acquisitions

AMONG recent additions to the zoological collections is the skull of a swamp deer (*Rucervus duvaucelli*) from India presented by Mr. D. H. Keelan. The specimen is remarkable for the symmetry of the antlers. A collection of mammals formed by the late Captain H. D. Hilton-Simpson has been presented by Mrs. Hilton-Simpson; included in this series is a mounted head and a skull of a race of buffalo named by the late Richard Lydekker after Captain Hilton-Simpson, *Syncerus caffer simpsoni*. A number of mammals from Kenya Colony, including a specimen of a rare crested bush rat, *Lophiomys testudo*, and twenty small mammals from Sierra Leone are the gifts respectively of Colonel C. H. Stockley and Mr. R. R. Glanville. An 'ivory pearl' from the tusk of a Uganda elephant has been presented by Mr. Q. O. Grogan. This concretion is an especially large one and shaped rather like a small potato. Among recent donations received from the Rowland Ward Trustees is an African tiger cat, *Felis celidogaster*, mounted for the galleries, and the skull of an African dwarf buffalo. A splendid group of slender prisms of stibnite (antimony sulphide) and another specimen of baryte on stibnite from Baia Sprie, Rumania, are the most interesting of the purchases made for the Department of Mineralogy. The Geological Survey of India has presented to the same Department three samples of different grades of diamondiferous gravel from the Karnool District, Madras Presidency. Diamonds in this district are obtained from alluvial deposits and also from a conglomerate at the base of the Karnool Series among rocks of Precambrian age. These gravels have been presented in response to a request for specimens to illustrate the modes of occurrence of diamond, which is the subject of the first section of the diamond case (near entrance to the Mineral Gallery) recently rearranged

THE Department of Botany has purchased about 700 drawings and some manuscript of J. J. Dillenius, the first Sherardian professor of botany at Oxford. In 1719, Dillenius published his "Catalogus Plantarum

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# NATURE

## SUPPLEMENT

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# Science in the Seventeenth Century*

By Prof. E. N. da C. Andrade, F.R.S.

### The Authority of Aristotle

THE sixteenth century was a period of reference to written authority, and in science the supreme rulers were Aristotle in all that pertained to the exact sciences and to general biology, and Galen in all that pertained to medicine. Occasionally a doubter arose, such as Paracelsus, only to be, at best, overwhelmed with ridicule and contempt, or, at worst, more drastically suppressed, as exemplified by the case of Giordano Bruno, who was burnt in 1600. The opinion widely expressed was that the world, Nature and particularly the human intellect, were in process of decay which had set in since the glorious times of classical Greece: it was seriously contended that the great minds of antiquity represented a race of giants which had died out just as the race of physical giants had died out. In particular, the works of Aristotle were supposed to fix the limits to which the human intelligence could reach, and the obvious thing to do, when seeking information as to the way in which Nature worked, was to refer to these works.

The method of Aristotle was, of course, speculative. Starting with certain philosophical ideas as to the nature of matter, derived partly by direct apprehension, partly by reasoning from a few observed facts of Nature, such as the circular motion of the stars, he proceeded by logical processes to argue how Nature should behave in order to conform with his innate ideas as to harmony and balance. This is no place to discuss the Aristotelian doctrine of form, which exercised so profound an influence on those who came after him; but it is necessary for our purpose to refer briefly to his ideas on motion and mechanics in general. He made a clear distinction between natural motion and violent, or artificial, motion. From the motion of the heavens he concluded that motion in circles was a natural motion. From the spontaneous motion of dropped bodies downwards, and of smoke and fire upwards, he concluded that a vertical motion was also a natural motion, adding to the idea of gravity downwards that of levity upwards. The four elements, earth, fire, air, and water played an essential part in the Aristotelian scheme; earth and water strove downwards, air and fire upwards.

The motion of a projectile or any propelled body, was a violent, or non-natural, motion. His fundamental error in considering these non-natural motions lay in his belief that bodies only moved so long as a force was acting upon them; he supposed that a thrown body continued in motion after it left the hand only because the moved air beat on it behind and carried it forward. It may be pointed out that this was an idealization, not an observed fact. A body set in motion by a force is observed ultimately to come to rest; he supposed that it would come to rest at once if the force ceased at once, but that the action of the force was continued by the air, ultimately dying out. Another idealization of the observed fact is to suppose that a body set in motion would continue to move, after the force had ceased to act, with a uniform velocity for

* Friday evening discourse delivered at the Royal Institution on February 18.

Fig. 1.
SANTBECH'S CONCEPTION OF THE TRAJECTORY OF A PROJECTILE; MODUS VIOLENTUS AND MODUS NATURALIS

How profound was the influence of Aristotelian mechanics in the sixteenth century, even in discussion of practical matters, is well exemplified in Santbech's discussion of the motion of projectiles, published in 1561. He states that the motion of a projectile consists of an oblique violent motion which suddenly ceases, and is succeeded by a natural motion of vertical fall. He gives diagrams (of which Fig. 1 is an example) showing the path of a cannon ball as two sides of a right-angled triangle, the hypotenuse representing the violent motion, and the vertical side representing the vertical fall on to the object aimed at. On this basis he proceeds to solve problems in ballistics. Other writers of about this time, apparently feeling uneasy about the sharp angle at the highest point of the trajectory, replaced it by a circular arc joining the straight-line oblique motion to the straight-line natural fall, the motion in this arc being a mixed mode, so that the whole trajectory consists of a straight line *modus violentus*, a curved *modus mixtus*, and a straight vertical *modus naturalis* (Fig. 2). It is a strange comment on the way in which these writers refused to let observation influence them that in a book by Rivius, published in 1547, the discussion of ballistics is carried out in terms of trajectories of this kind,

ever, were it not that adventitious forces, such as friction, act upon it, and ultimately bring it to rest. The latter is Galileo and Newton's idealization, which now lies at the basis of our mechanics. Neither of the two is inherently more probable than the other; only experiment and observation have convinced us that the modern view is the scientifically correct one.

As regards fall in particular, Aristotle considered that a moving body was acted upon by a power moving it and by a resistance: if power and resistance were equal the body did not move. This is a fundamental mistake. It was argued by others (but apparently not explicitly by him) from his fundamental conceptions that the time of fall of a body was inversely as its weight. Experiment had no part in his scheme, probably because he was dealing with first causes, and isolated material phenomena he held to be without fundamental significance. Form was more important than matter. We see something of his point of view in the works of certain modern economists, who regard actual economic events as of little significance.

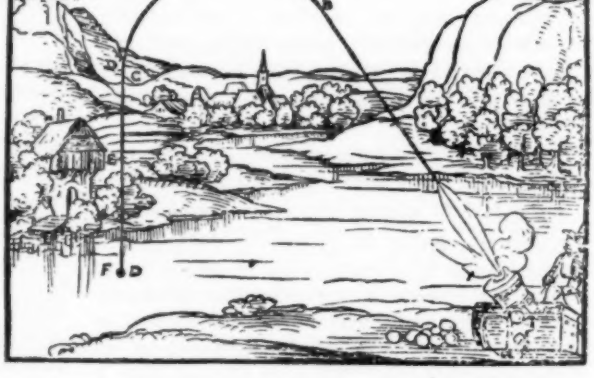


Fig. 2.
MODUS VIOLENTUS, MODUS MIXTUS AND MODUS NATURALIS

while in pictures in the same book, in which the artist shows the bombardment of a town, the trajectories of the bombs are shown as tolerably correct representations of the path of a real projectile.

Let us look at the position at the opening of the seventeenth century. Copernicus had published his "De Revolutionibus" in 1543, when he was on his death-bed, but the astronomers who followed him were divided in their attitude towards his theory. Giordano Bruno, who upheld the Copernican hypothesis, was burnt in 1600; Rheticus, Reinhold and Mästlin contended for the theory; not only Luther and Melanchthon, but also the great observer Tycho Brahe, who died in 1601, pronounced against it. Kepler (1571–1630) was, on the other hand, a Copernican. He had published his "Prodromus" in 1596, in which book he traced a mystical connexion between the distances of the planets, and the radii of six concentric spheres, between which the five regular solids were fitted. This was, of course, in the spirit of Pythagoras, who saw in the heavens a mysterious harmony which could be expressed in numbers.

Kepler's famous laws were not published until the century had well started, the first and second in the "Astronomia Nova", 1609, and the third in the "Harmonices Mundi", 1619. These laws gave the geometrical form of the planetary orbit, and a time-table for their progress in these orbits, but envisaged no quantitative mechanism to account for that form and that timetable. At the beginning of the century he considered that planets must have some kind of souls to urge them on in their paths, but later he resorted to a magnetic influence emanating from the sun, of a kind, however, that did not in any way correspond to the laws of magnetism as we know them, for he supposed that it was the rotation of the sun on its axis that was responsible for the urge. His great difficulty in the way of mechanics was that he had no conception of inertia. Of mutual gravitation he had, however, some idea, and even explained the tides as due to an attraction of the moon for the waters of the earth. Probably his magnetic hypothesis was due to Gilbert's book, "De Magnete", the appearance of which in 1600 aptly inaugurated the century which saw the triumph of the experimental method.

## The Mechanics of Galileo

The first great name with which we have to deal, if we wish to trace the rise of modern mechanics, is Galileo, who was born in 1564, the year in which Michelangelo died. Everybody knows the legend that, as a young man in Pisa, he confuted the Aristotelians by letting spheres of different masses fall from the tower of Pisa, and observing that they all took the same time to reach the ground—a legend, because the indefatigable researches of Wohlwill have shown that it is highly improbable that he ever carried out this experiment. The story that he did so is due to Viviani, who published his book in 1654, twelve years after Galileo's death, and who first met Galileo towards the end of his life. Galileo was in Pisa from the seventeenth to the twenty-eighth year of his age, and there seems no doubt, that, as we should expect, when he first began to lecture he believed what he had been taught, and was a devout Aristotelian. The experiment which he actually carried out was to let fall a lead and a wooden sphere, and what he noted was that the wood fell more quickly at first, but that later on the lead overtook it, and reached the ground first! He was at the time too much of an Aristotelian to attach much importance to this finding that, of two bodies of equal size, the heavier fell slower at first but afterwards quicker.*

Later he turned against the pseudo-Aristotelian belief that the rate of fall was proportional to the weight. This was not due to experiment, but to an appeal as to what was reasonable. He says "If we let two stones fall from a high tower, one twice as big as the other, it is ridiculous to suppose that when the big one has reached the ground, the other will be only half way down", but he adds "we will work more with reasoning than with examples, for what we seek is the cause of phenomena, which experience does not provide", a very Aristotelian sentiment. It was not until later that he showed that genius for experiment which is one of his great claims to fame. In short, he did not suddenly, as a young man, reject the whole body of knowledge in which he had been brought up, but he gradually freed himself from the scholastic point of view, and laid the foundations of modern science.

In popular estimation, Galileo is, perhaps, best known as the man who first turned the telescope to the serious study of the heavens—in fact he is often attributed with the discovery of

* The question of the supposed experiment at Pisa is discussed in a very scholarly manner by Prof. Lane Cooper in a little book "Aristotle, Galileo and the Tower of Pisa", which has come to my notice since this discourse was delivered. The learned author, who is professor of the English language and literature in Cornell University, sets an example to some of his scientific brethren who write on such matters, by his constant reference to the original sources. I am glad to find that his conclusions support what is written above.

the telescope, although actually what happened was that, having heard that such an instrument had been made in Holland, he himself made one without being supplied with details as to the method of construction. His observations were of the first importance. The discovery of the mountains of the moon struck the popular fancy. It is the one point to which Milton, who visited Galileo in his old age, refers in "Paradise Lost".

> "his pond'rous shield
> Ethereal temper, massy, large and round,
> Behind him cast; the broad circumference
> Hung on his shoulders like the Moon, whose Orb
> Through Optic Glass the *Tuscan* Artist views
> At Ev'ning from the top of *Fesolé*,
> Or in *Valdarno*, to descry new Lands,
> Rivers or Mountains on her spotty Globe."

The lunar landscape at once suggested that the moon might be inhabited, as discussed, for example, in Wilkins' "The Discovery of a World in the Moone" (1638). The discovery of the phases of Venus established the rotation of that planet round the sun, and, as a matter of fact, the fact that they were not observed with the naked eye had been recognized as a difficulty by Copernicus, who explained it away by suggesting that Venus was transparent. In the discovery of sunspots, which was a blow for the Aristotelians, since it showed that the eye of the world was not perfect, he was anticipated by Fabricius. He observed that the Milky Way consisted of innumerable stars. As regards Saturn, owing to the position of the rings and the imperfect resolution of his telescope, he concluded that the planet was accompanied by two satellites practically touching it, or, as he said, "I have observed the planet Saturn to be triple"—*altissimum planetam tergeminum observavi*.

Probably the most important discovery which Galileo announced in his "Siderius Nuntius", or "Messenger from the Stars", was the existence of the satellites of Jupiter, which, revolving round the planet, gave a picture of the Copernican system. His astronomical discoveries, then, form an imposing collection, but Lagrange, whose opinion on anything that pertains to the science of mechanics must carry immense weight, makes light of them in comparison with Galileo's services as the founder of the science of mechanics, "Les découvertes des satellites de Jupiter, des phases de Vénus, des taches du Soleil, etc. ne demandaient que des télescopes et de l'assiduité; mais il fallait un génie extraordinaire pour démêler les lois de la nature dans des phénomènes que l'on avait toujours eus sous les yeux, mais dont l'explication avait néanmoins toujours échappé aux recherches des philosophes." Although we may not agree that anyone with a telescope—especially such a telescope as Galileo possessed—and industry, could have made his astronomical discoveries, yet there is no doubt that the way in which Galileo made mechanics into a science is a most striking testimony to his genius.

The great book in which he announced his fundamental discoveries in mechanics, "Discorsi e dimostrazioni matematiche intorno a due nuove scienze", appeared in 1638. In it he established the law of fall, and the parabolic motion of a projectile in a non-resisting medium. He deduced the law of fall from the supposition that there were equal increments of velocity in equal small intervals of time; in the course of his arguments he considered any time interval as capable of being divided into an infinite number of instants, and so foreshadowed the differential method. He did not, however, connect a uniform acceleration with a uniform force, but apparently attributed the increase in velocity to an increase in force during the fall, and, further, he did not think of the fall as due to the attraction of the earth but rather to some urge inherent in the body. As to the true cause of the acceleration, however, he expresses the same kind of reticence as was shown by Newton concerning the nature of the gravitational force. We may take, for example, Salviati's speech on the third day of the dialogues: "The present does not seem to be the proper time to investigate the causes of the acceleration of natural motions, concerning which various opinions have been expressed by various philosophers, some explaining it by attraction to the centre, others by repulsion between the very small parts of the body, whilst others attribute it to a certain stress in the surrounding medium, which closes in behind the falling body and drives it from one of its positions to another, which fantasies, and others like them, create problems requiring examination, but there would be little gain were they solved. At present it is the purpose of our author merely to investigate and to demonstrate some of the properties of accelerated motion, whatever the cause of the acceleration may be."

Galileo perfectly understood inertia in the case of horizontal travel, and used the fact that, in the absence of horizontal force, a body travels horizontally with a uniform speed, in his investigation of the path of a projectile. It is strange, then, that he seems to have no conception of inertia in

the case of the vertical motion of free fall. It has been suggested that this is possibly a relic of his Aristotelian training, a horizontal motion in the direction of the earth's surface, that is, in a very large circle, being a perfect motion, like that of the heavenly bodies. There seems no need, however, to resort to this supposition; an accelerated motion is clearly harder to bring into any scheme than a uniform translation, as is sufficiently shown by the history of Einstein's theory of relativity. In any event, assuming equal increments of velocity in equal elements of time, he found, by what is essentially graphical integration, that the space traversed was proportional to the square of the time.

He verified this law experimentally by measuring the time taken by a body rolling on an inclined plane to traverse various distances, measuring the time by a water clock, and "in such experiments, repeated a full hundred times, we always found that the spaces traversed were to each other as the squares of the times, and this was true for all inclinations of the plane along which we rolled the ball. We also observed that the times of descent for various inclinations of the plane bore to one another precisely that relation which, as we shall see later, the author had predicted and demonstrated for them."*

The law referred to in the last sentence is essentially that the velocity is given uniquely by the vertical drop. This Galileo proved in a most ingenious way by drawing aside the bob of a heavy pendulum until it reached a fixed height, and letting it fall so that the string struck a nail vertically under the point of support. No matter at what height this nail was placed, that is, no matter what the curvature of the arc along which the bob rose, the height which it attained was always the same, and equal to that through which it fell. The velocity at the lowest point being always the same, it follows, considering the motion reversed, that the velocity is independent of the curvature of the arc along which the bob is constrained to move. From this he concluded that a similar result would hold true for planes of different slopes.

The parabolic law for projectiles Galileo proved by combining a uniform velocity in the horizontal direction with the law of fall, having previously proved that, with a body projected vertically upwards, the time of rise to the highest point is equal to the time of fall from that point. With great ingenuity he verified the parabolic form by rolling a metal ball on a slightly inclined plane metallic mirror: "In the execution of this method, it is advisable to heat and moisten the ball slightly by rolling it in the hand in order that its trace upon the mirror may be more distinct." The experiment may be carried out to-day by covering with carbon copying paper a sheet of white paper attached to a board and rolling a heavy metal ball over it.

It is hoped that these few words will be enough to suggest the acumen and experimental skill with which Galileo founded the science of particle dynamics. This work was the first great step towards the Newtonian synthesis, but of universal gravitation he had not the slightest inkling, as a passage where he speaks of dropping stones from the moon on to the earth is sufficient to show.

### Bacon and Descartes

In any account of the scientific thought of the seventeenth century there are two philosophers whose names always appear prominently, Francis Bacon and Descartes. Bacon was a Lord Chancellor and Descartes was a great mathematician, but what we have here to consider are their writings on method, especially scientific method. As regards Bacon's services to science, we have a great diversity of opinion among those who have made a careful study of his works. Macaulay, Spedding, and very recently, Prof. R. F. Jones of the University of Washington, speak of him in terms of the highest commendation. On the other hand, William Harvey, the discoverer of the circulation of the blood; Liebig, the great chemist; the philosophers Lasson and Dühring; the Anglo-American man of science J. W. Draper, who carried out important researches in photo-chemistry and was the author of the "History of the Intellectual Development of Europe"; and Sir Oliver Lodge, all speak strongly against his claims to be considered an important influence in the history of science.

Macaulay says of Bacon, for example, "As we have lying before us that incomparable volume, the noblest and most useful of all the works of the human reason, the Novum Organum . . .", which passage we may, perhaps, characterize in Macaulay's own words as the "noxious sweetness of his undiscerning praise". On the other hand, Aubrey tells us of Harvey that "he had been physician to the Lord Chancellor Bacon, whom he esteemed much for his wit and style, but would not allow him to be a great philosopher. . . .

* It need scarcely be said, perhaps, that the author referred to in this quotation is himself.

'He wrote philosophy like a Lord Chancellor', he said to me speaking in derision". Draper is violent in his condemnation, saying of Bacon that he was "a pretender in science, a time-serving politician, an insidious lawyer, a corrupt judge, a treacherous friend, a bad man"; but he is no more violent than Liebig. Elsewhere Draper says, with justice, that Bacon's "chief admirers have been persons of a literary turn, who have an idea that scientific discoveries are accomplished by a mechanico-mental operation". Finally we may quote Sir Oliver Lodge, the kindliest and most courteous of men, whose verdict is that "on the solid progress of science he may be said to have had little or no effect".

Bacon had a purely utilitarian view of science, saying that "the real and legitimate good of the sciences is the endowment of human life with new inventions and order". To him is often attributed the adoption of the experimental method, as distinguished from the speculative method of Aristotle, and he himself is continually boasting that he brings a new method to the overthrow of Aristotle; but his whole terminology is scholastic, with its sensible qualities, matter and form, and he totally lacks any feeling for the methods by which science has been advanced. He was a stranger to quantitative work, and he had an aversion from the method of the working hypothesis, to which science actually owes its advances. One instance of this is his condemnation of the Copernican system, which he holds to be "the speculations of one who cares not what fictions he introduces into nature provided his calculations answer".

It is characteristic of Bacon that, while continually laying stress on his own work as a forerunner, and of his importance as *instaurator artium*, he totally ignores the pioneering scientific work of his great contemporaries. He says nothing of Galileo, although it is quite clear, from a letter of Sir Tobie Matthew's which we possess, that the work had been brought to his notice. He derides Gilbert, and when he himself discusses the magnet he ignores the repulsion between like poles. Kepler and Harvey made no impression upon him, although, as we have seen, he was in close personal touch with the latter. In short, he could not recognize real scientific advances when he saw them.

In spite of Bacon's attack on Aristotle, his outlook was really Aristotelian. He says, for example, that we must investigate what bodies are light, what heavy, and what neither light nor heavy. His whole treatment of motion is spun from his own mind, in the Aristotelian tradition. He lays down, for example, in the "Novum Organum", that there are nineteen different kinds of motion, which he describes at length in the spirit of the Middle Ages, rather than that of science as we understand it. Of the last kind of motion, for example, he says, "let the nineteenth and last motion be one which can scarcely be termed a motion, and yet is one; and which we may call the motion of *repose*, or of abhorrence of motion. It is by this motion that the earth stands by its own weight. . . . It is owing to the same tendency, that all bodies of considerable density abhor motion, and their only tendency is not to move, which nature they preserve although excited and urged in a variety of ways to motion."

For a general description of Bacon's method we will, so as to avoid any appearance of prejudice, adopt that of his worshipper, Macaulay: "Make as large a list as possible of those bodies in which, however widely they differ from each other in appearance, we perceive heat: and as large a list as possible of those which, while they bear a general resemblance to hot bodies, are nevertheless not hot. Observe the different degrees of heat in different hot bodies: and then, if there be something which is found in all hot bodies, and of which the increase or diminution is always accompanied by an increase or diminution of heat, we may hope that we have really discovered the object of our search." We will only add that among the hot bodies which he classifies are horse-dung and pepper.

The collection of the material Bacon was prepared to delegate to any journeyman. The man of science was then to go through this material in a mechanical way, according to the prescribed rules, and so make great discoveries. I hold that we can, without unfairness, say that he worked out elaborate and impossible schemes for investigating phenomena of no importance. On the other hand, it is indisputable that he was often cited with admiration by some of the great experimenters who founded the Royal Society, and held up as the man who fought for the experimental method. He appears, for example, in the frontispiece designed by John Evelyn and etched by Wenceslas Hollar for Spratt's "History of the Royal Society", which, published in 1667, is really a history of the foundation and objects of the Royal Society. Robert Boyle, in particular, always speaks of him with the highest praise,

even though he points out that Bacon's determination of the specific gravity of quicksilver is somewhat incorrect: "Whereby it appears the weight of water to quicksilver is as 1 : 13$\frac{10}{19}$, though our illustrious Verulam (questionless not for want of judgement or care, but of exact instruments) makes the proportion between these two liquors to be greater than 1 : 17."

Newton, however, never refers to Bacon, and Hooke certainly very seldom. I believe that the respect that some working men of science in the seventeenth century felt for him was due to his lofty position as Lord Chancellor, and to the fact that he, influential and exalted as he was, spoke so strongly of the need for the experimental method, and attacked Aristotle. That Bacon had no conception of the right way of applying the experimental method, and himself used the terminology and almost the method of Aristotle, is unimportant compared with the fact that he continually spoke of the need for a new method which should handle observed properties. Again, in the "New Atlantis", Bacon describes Solomon's House, "dedicated to the study of the Works and Creatures of God", which was his scheme of a great institution for experimental research. A foundation of this kind was the dream of the men who did most to found the Royal Society, and Bacon's fiction of a munificently endowed college for scientific research was one that set him high in the esteem of the enthusiasts of the new learning.

Renée Descartes offered a mechanical explanation of the universe, evolved by him from a philosophical theory of first causes. His system had a far-reaching influence. Its ready acceptance was, no doubt, due to the way in which he explained all phenomena in general and pictorial terms, which could be followed without any mathematical discipline, for, great as were Descartes's mathematical powers, his mechanism of the universe was purely quantitative. In spite of the overthrow of the system by Newton in 1687, his influence continued far beyond the end of the seventeenth century, especially in France, where great controversies between Cartesians and Newtonians took place round about 1735.

Descartes set out, in the Aristotelian spirit, to build up his scheme from first causes, and he criticizes Galileo for ignoring such causes, saying that by doing so he had built without foundation. Descartes assumed extension as the essential property of matter: as there could be no extension

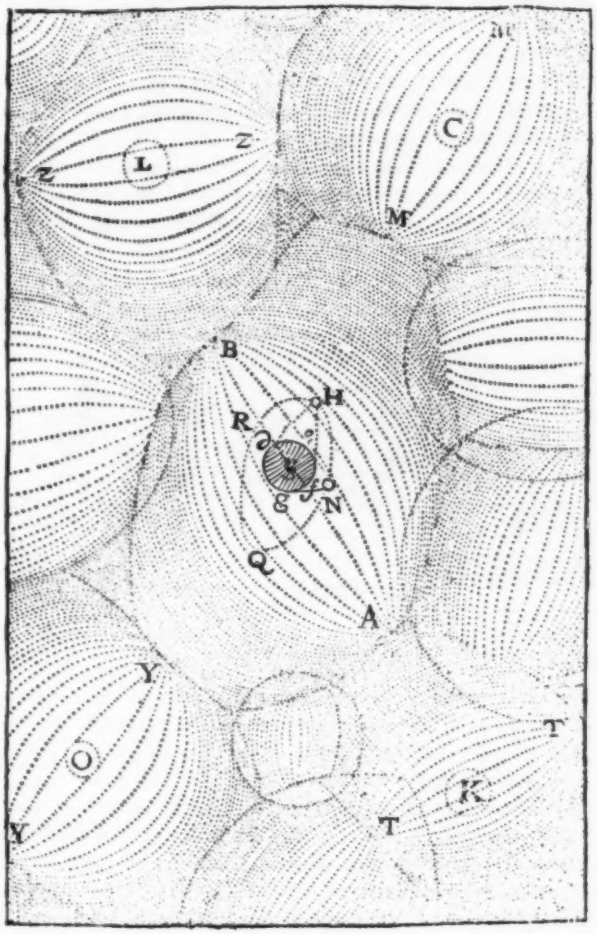


Fig. 3.

DESCARTES'S SCHEME OF VORTICES, SHOWING THE VORTEX OF THE SOLAR SYSTEM IN THE MIDDLE.

without matter, there could be no vacuum. Motion of matter was only possible if something material occupied the space vacated by the moving body. It was from arguments of this kind that Descartes evolved his vortices, in which matter moved in closed paths. He distinguished three kinds of matter. The original kind, called into being by the Creator, consisted of medium-sized particles, which, from his fundamental ideas, cannot have been spherical but must have filled

all space without interstices. These particles, when rubbed down by their continual motion, constituted his second kind of particles, or heavenly matter. The dust rubbed off from them constituted the first kind of matter. Some of these particles forced through the interstices of the particles of the second kind, became spiral and matted together to form the third kind of particles. The luminous sun and stars were formed of the first kind of matter, the heavens of the second, and the crust of the earth and planets were formed of the third kind of particle.

The heavenly vortices (Fig. 3) themselves consisted of circulations of particles of the second kind, carried round by the rotation of the central bodies. The planets were carried round by

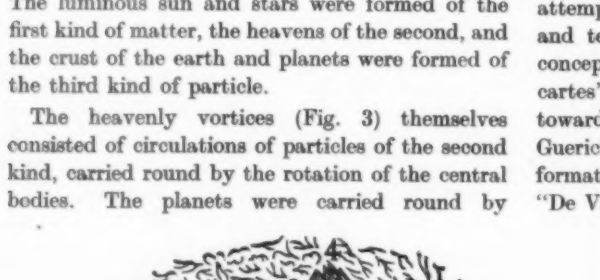


Fig. 4.

DESCARTES'S SCHEME OF THE EARTH, SHOWING THE FORMATION OF MOUNTAINS.

the sun's vortex. Descartes develops his system in great detail, making it account for the formation of the earth, with its mountains due to the movements of the crust (Fig. 4); for the phenomena of light and magnetism, in which latter connexion he was the first to show magnetic lines of force by means of iron filings; and for the motion of the heavenly bodies, including the comets, although the latter gave him particular difficulty. The whole of his heavenly mechanics is purely descriptive: he gives the particles of his vortices any velocities and properties that he likes, and he makes no attempt, for example, to express quantitative laws, such as Kepler's laws, in terms of his fundamental conceptions.

Nevertheless, Descartes does lay down laws of motion, which foreshadow Newton's laws. His first law is practically the law of inertia—every body, so far as it can, will persist in its particular state, so that what is once in movement will always be in movement. The second law is that every body tends to move in a straight line and that bodies which move in a circle always tend to move away from the centre of the circle. The third law dealt with impact.

### THE ROYAL SOCIETY AND ROBERT HOOKE

Although he dealt with the laws of impact, and with the laws of optics, Descartes laid no emphasis on experiment. He did, however, attempt a general synthesis, explaining heavenly and terrestrial mechanics in terms of the same conceptions, and so made a great advance. Descartes's life ran from 1596 to 1650. Somewhere towards the end of it (the exact time is not known) Guericke carried out his great experiment on the formation of a vacuum, but Guericke's book "De Vacuo Spatio" was not published until 1672.

In the meantime, Copernican views were gaining strength. In 1638, for example, John Wilkins published a stout defence of the Copernican system. John Wilkins is a figure of great importance for English science, although he carried out no original work, for he was instrumental in the formation of the Royal Society, the foundation of which, with the other great European academies, the Académie Royale des Sciences and the Accademia del Cimento, gave an immense impulse to the experimental method.

It was in 1645 that Wilkins began to have in his rooms those gatherings of natural philosophers which formed the beginnings of the Royal Society. We have not leisure to trace the history of these meetings, nor the relative parts played by Oxford and London. Suffice it to say that the Royal Society was founded in 1662, with Wilkins as the first secretary, and numbered among its original members Seth Ward, Robert Boyle, Sir William Petty, Lord Brouncker, Robert Hooke, John Wallis, Francis Willughby and Sir Christopher Wren, as well as Christian Huygens.

The foundation of the Royal Society was followed by a burst of scientific discovery, in which Robert Hooke played a great part. Robert Hooke, physically insignificant, crooked and weakly, was one of the greatest mechanical geniuses that the world has seen: Pepys wrote of him "who is the most, and promises the least, of any man in the world that ever I saw". He lacked Newton's gigantic mathematical powers and searching analysis, but he had a wonderful instinct for scientific truth, and an extraordinary fertility of invention. One or two quotations from

his "Attempt to prove the motion of the earth", published in 1674, may give a taste of his quality. In this treatise he describes, among other things, a very careful attempt which he made to measure the parallax due to the earth's motion with reference to the fixed stars, and he correctly attributes his negative result to the distances of these stars, saying:

"To me indeed the Universe seems to be vastly bigger then 'tis hitherto asserted by any Writer, when I consider the many differing magnitudes of the fixt Stars, and the continual increase of their number according as they are looked after with better and longer Telescopes. And could we certainly determine and measure their Diameters, and distinguish what part of their appearing magnitude were to be attributed to their bulk, and what to their brightness, I am apt to believe we should make another distribution of their magnitudes, then what is already made by *Ptolomy*, *Ticho*, *Kepler*, *Bayer*, *Clavius*, *Grienbergerus*, *Piff*, *Hevelius* and others."

At the end of the treatise Hooke quotes three "suppositions", upon which he says the system of the world should be founded:

"First, That all Cœlestial Bodies whatsoever, have an attraction or gravitating power towards their own Centers, whereby they attract not only their own parts, and keep them from flying from them, as we may observe the Earth to do, but that they do also attract all the other Cœlestial Bodies that are within the sphere of their activity; . . . The second supposition is this, That all bodies whatsoever that are put into a direct and simple motion, will so continue to move forward in a streight line, till they are by some other effectual powers deflected and bent into a Motion, describing a Circle, Ellipsis, or some other compounded Curve Line. The third supposition is, That their attractive powers are so much the more powerful in operating, by how much the nearer the body wrought upon is to their own Centers. Now what these several degrees are I have not yet experimentally verified; but it is a notion, which if fully prosecuted as it ought to be, will mightily assist the Astronomer to reduce all the Cœlestial Motions to a certain rule, which I doubt will never be done true without it."

Before saying anything further about the part that Hooke played as a forerunner of Newton, we will briefly refer to some of his performances in other fields. He was the first man to make a really successful compound microscope, and with it made numerous discoveries, including that of cells in plants, which he was the first to name. In connexion with his work on springs he enunciated Hooke's law, and he discovered the balance wheel of watches, which probably Huygens discovered independently—the matter is disputed. He invented a group of meteorological instruments—a hygrometer, an anemometer, a self-registering thermometer and a self-registering rain gauge. In astronomy he devised the first clock-driven telescope (Fig. 5), and the first circle-dividing machine, which Ramsden afterwards perfected, and he insisted upon the importance of telescopic sights in this connexion, explaining and measuring the resolving power of the eye. He was the first to carry out systematic experiments on the colours of thin plates, and he invented an early form of Savart's wheel, to be used as a siren. His geological work, especially that on fossils, is fundamental. Many other instances could be given of his fertile genius.

Returning to the laws of celestial motion, in 1679 Hooke, who was then secretary of the Royal Society, wrote to Newton to ask him for a paper, to be read before the Society. Newton replied with a letter concerning the place where a falling body would hit the surface of the earth, pointing out that owing to the motion of the earth, it would fall east of the perpendicular. He also stated that the path should be a portion of a spiral terminating at the centre of the earth. Commenting on this letter, Hooke said that Newton was in error: the path would be an "eccentrical elliptoid, supposing no resistance of the medium: but supposing a resistance, it would be an eccentric ellipti-spiral . . . the fall of the body would not be perfectly east as Mr. Newton supposed: but to the south-east, and more to the south than the east". What Hooke meant by an "eccentrical elliptoid" we can only conjecture. Probably he meant a curve something like an ellipse, with the attracting point away from the centre: his extraordinary physical instinct may well have been sufficient to assure him of this without his being able to prove that it was an ellipse. Hooke's criticisms were substantially correct, as Newton realized, and to be caught in error irritated Newton in the highest degree. In his reply Newton admitted that the body would fall to the south, and that "if gravity be supposed uniform it will not descend in the spiral to the very centre, but circulate with an alternating ascent and descent made by its *vis centrifuga* and gravity alternately overbalancing one another".

It is clear from this and the rest of the reply, that Newton had not yet attained his later clarity on the problem of gravitation. There is little

doubt that this correspondence revived his interest in the problem, which, as we shall see, had been very keen some thirteen years earlier. The bitterness between Newton and Hooke, which continued until Hooke's death, was a sad feature of the lives of two great men, both wholeheartedly devoted to scientific truth. It seems certain that by the intercession of tactful friends it might have been much diminished, if not entirely removed. Unfortunately, it was exacerbated by Oldenburg, long the secretary of the Royal Society, who missed no opportunity of embittering the relationship.

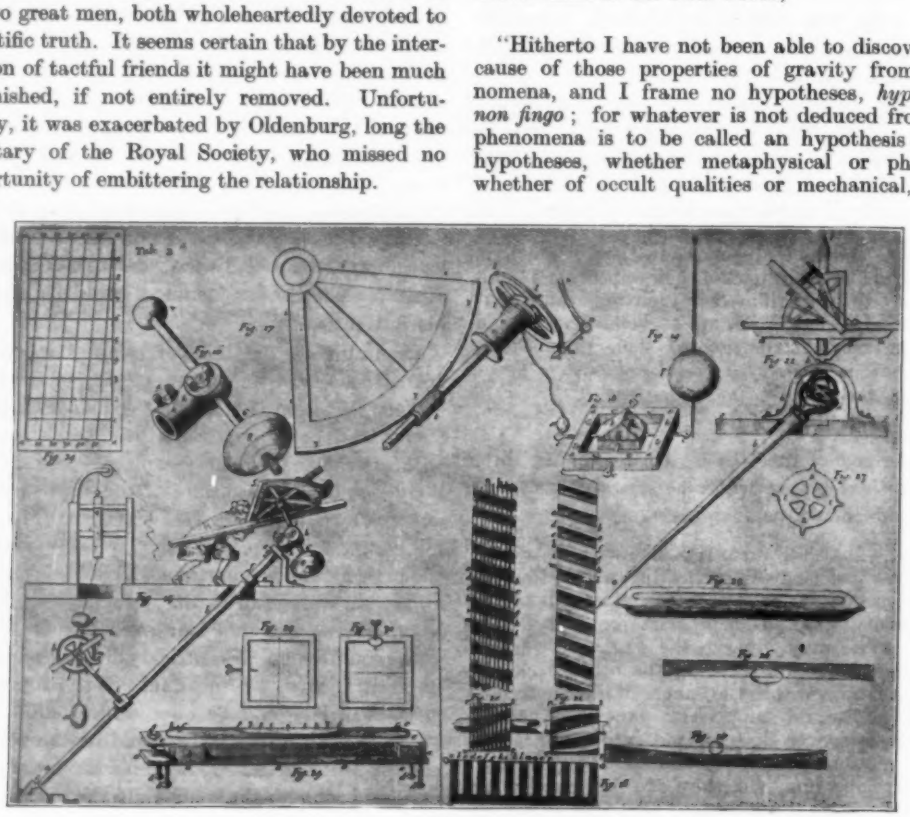

Fig. 5.

AN ENGRAVING FROM HOOKE'S "ANIMADVERSIONS", SHOWING HOOKE'S JOINT, THE CLOCK-DRIVEN TELESCOPE, THE METHOD OF DIAGONAL DIVISIONS, STEPPED AND HELICAL GEARS AND THE BUBBLE LEVEL. THE LAST-NAMED IS CLAIMED FOR THEVENOT, BUT THERE SEEMS NO DOUBT THAT HOOKE INVENTED IT INDEPENDENTLY.

## ISAAC NEWTON: LAWS AND HYPOTHESES

There is general agreement that Newton is the greatest scientific mind that the world has known. He produced that body of mechanics, founded on a few precise laws—the three laws of motion and the inverse square law of gravitation—which, in its essence, is still sufficient to cover the whole body of celestial and terrestrial mechanics of macroscopic bodies moving with velocities small compared with that of light. He founded the science of mathematical physics, and was, in addition, an experimenter of the very highest order, as his "Opticks" and, for example, his experiments with pendulums suffice to show. He also stated with the greatest clarity the attitude which has dominated physics from his time until the present day, with possibly one or two very recent exceptions. This attitude we cannot express better than in his own words,

"Hitherto I have not been able to discover the cause of those properties of gravity from phenomena, and I frame no hypotheses, *hypotheses non fingo*; for whatever is not deduced from the phenomena is to be called an hypothesis; and hypotheses, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy. In this philosophy particular propositions are inferred from the phenomena, and afterwards rendered general by induction. Thus it was that the impenetrability, the mobility, and the impulsive force of bodies, and the laws of motion and of gravitation, were discovered. To us it is enough that gravity does really exist, and act according to the laws which we have explained, and abundantly serves to account for all the motions of the celestial bodies, and of our sea."

His attitude here expressed is in direct contradiction to that of Descartes, who made hypotheses as a result of pure reflection and from these hypotheses constructed the world.

The history of Newton's theory of gravity begins at Woolsthorpe, where he was in 1665–66 to avoid the plague. His own account of this period was written in 1714, and his recollections may have been coloured by what had happened in the intervening period, but his words are of such interest that I cannot refrain from giving them:

"In the same year (1666) I began to think of gravity extending to the orb of the moon, and having found out how to estimate the force with which a globe revolving within a sphere presses the surface of the sphere, from Kepler's Rule of the periodical times of the planets being in a sesquialterate proportion of their distances from the centres of their orbs I deduced that the forces which keep the planets in their orbs must [be] reciprocally as the squares of their distances from the centres about which they revolve: and thereby compared the force requisite to keep the moon in her orb with the force of gravity at the surface of the earth, and found them answer pretty nearly. All this was in the two plague years of 1665 and 1666, for in those days I was in the prime of my age for invention, and minded mathematics and philosophy more than at any time since."

The extraordinary thing is that, at the time, Newton published nothing on the subject—extraordinary, perhaps, but less extraordinary with Newton than with any other man, because he always had to be urged to publication, largely, I think, because of his horror of controversy. The generally accepted story is that, owing to a discrepancy of some 16 per cent, due to his taking an incorrect radius of the earth then current, Newton put the work aside, being dissatisfied with this degree of accuracy. This does not, however, seem likely: nobody better than Newton could estimate what degree of precision was likely to have been attained in a given measurement. We must remember the hypotheses on which the calculation is based, namely, that the gravitational effect of the earth extends to the moon, falling off inversely as the square of the distance, and that the gravitational acceleration at the surface of the earth is only another manifestation of the earth's attraction. It is clear that when we are considering the moon it does not much matter at what particular point of the earth we consider the earth's mass to be concentrated, but when we are considering the surface acceleration this point is of the greatest importance. It is far from being obvious that the gravitational force at the surface of a sphere, each small part of which is exerting a force proportional to its mass and inversely proportional to the square of the distance, is the same as it would be if the whole of the mass of the sphere were concentrated at its centre. Until this has been proved the whole calculation is unsatisfactory, especially to a mind so acute and so scientifically honest as that of Newton. He would see at once that criticism could fasten on this point, and it seems far more likely that he put aside the work on account of his inability to answer such criticism than on account of the discrepancy to which his silence is usually attributed.

By 1685 Newton had succeeded in proving that the gravitational attraction of a spherical shell of uniform density on an external point is the same as it would be if the mass were concentrated at the centre. There was another point of difficulty: it was by no means clear *a priori* that the gravitational attraction was proportional to the motional inertia of a body, or that the ratio of the two was the same for all bodies. This point Newton settled by his famous experiments of the hollow pendulum carried out with enclosures of equal masses of very different substances—metals, glass, sand, salt, wood, wheat.

The incident of 1679, to which we have referred, brought Newton back to the problem of the orbit of a particle in a central gravitational field. In January 1683/4, Edmond Halley had a talk with Christopher Wren and Hooke on this problem. All three, apparently, tended towards the belief that celestial mechanics could be explained on the inverse square law of attraction, and Hooke declared that he was able to demonstrate this mathematically. Wren said that he would give a prize of "a book of 40s." to either of the others who could, in fact, bring a convincing demonstration. It is quite clear that Hooke never did so, and equally clear that he was incapable of such a mathematical feat. In August 1684, Halley, being at Cambridge, asked Newton what would be the curve described by a planet in an inverse square field of force and Newton immediately answered, "An ellipse", and, in reply to an amazed inquiry, said that he had calculated it. Later he produced the proof.

There is no space here to discuss how Halley instigated Newton to write the "Principia", saw the work through the press, and, although not a rich man, bore the charges. It is pleasant to reflect that he probably got his money back, as the work sold very quickly. As a minor historical mystery there seems no certainty at what price it was sold: More says probably for ten or twelve shillings a copy.

The spirit of the "Principia" may be said to be summarized in the first sentence of the "Opticks", "My design in this Book is not to explain the Properties of Light by Hypotheses, but to propose and prove them by Reason and Experiments". The book is astonishingly rich in matter fundamental to mathematical physics, containing, for example, the foundations of the theory of sound and of hydrodynamics. The treatment of Descartes's theory of vortices is typical. Newton points out that it is impossible, on Descartes's theory, to give a quantitative explanation of celestial mechanics, in particular to deduce Kepler's laws. In order to drag the planets round, the fluid matter of the vortices must behave in a viscous manner. Newton does not actually use the phrase "viscous liquid", but he lays down the fundamental behaviour of such liquids in the following "hypothesis": "the resistance arising from the want of lubricity in the paths of a fluid is, other things being equal, proportional to the velocity with which the parts are separated from one another", that is, the shear in a viscous fluid is proportional to the velocity gradient. From this he deduces that the periodic times of the paths of a fluid surrounding a revolving sphere are proportional to the squares of the distances from the centre of the sphere. He further points out fundamental difficulties in the vortex hypothesis in connexion with the motions at perihelion. He does not discuss the adequacy of the vortex hypothesis in general terms, but demonstrates clearly that the hypothesis could not account for the observed laws of planetary motion. The situation reminds us of the fate of the nineteenth century ether of space, which gave the same kind of easily grasped picture as did the vortices, but which had to be abandoned because it would not give the quantitative results required by the Michelson-Morley experiment.

Newton's attitude towards the question of the nature of gravitational force is typical of the man. Richard Bentley pressed him strongly to declare himself on this point, and we possess the letters which passed on both sides. Two passages may be cited as of particular interest: incidentally, in the Royal Institution copy of Horsley's "Newton" these passages are marked in pencil, and in each case we have the note at the side, in Dr. Bence-Jones's handwriting, "Mr. Faraday's marks". Newton says,

"You sometimes speak of gravity as essential and inherent to matter. Pray do not ascribe that notion to me; for the cause of gravity is what I do not pretend to know, and therefore would take some time to consider it", and again, "It is inconceivable, that inanimate brute matter should, without the mediation of something else, which is not material, operate upon, and affect other matter without mutual contact; as it must do, if gravitation, in the sense of *Epicurus*, be essential and inherent in it. And this is one reason why I desired you would not ascribe innate gravity to me. That gravity should be innate, inherent and essential to matter, so that one body may act upon another at a distance through a *vacuum*, without the meditation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking, can ever fall into it. Gravity must be caused by an agent acting constantly according to certain laws; but whether this agent be material or immaterial, I have left to the consideration of my readers".

This completes the particular story which I have tried to tell. What Newton ignores is what Aristotle and Descartes tried to start with.

I have endeavoured to show how, within a century, the method of constructing Nature by reasoning, more or less logically, from accepted philosophical ideas, was replaced by the method of appealing to Nature by experiment, and adopting only such laws as were in quantitative agreement with the results of experiment. I have tried to point out how the search in the mind for first causes gave way to a search in Nature for observable order and regularity, coupled with a disinclination to speculate beyond the facts. In a recent Friday Evening Discourse at the Royal Institution, Prof. Dingle spoke of a return to the Aristotelian method, which he detected, and deprecated, in the writings of one or two of our great contemporaries in science. What's to come is still unsure—it may be that a new spirit in science is being born, just as it may be that future ages will envy us for having been contemporary with the creation of Mr. T. S. Eliot's austere poems and Mr. Epstein's mighty monoliths. Be the future, however, what it may, it is the spirit of Newton that has guided us hitherto and that is the legitimate father of the work of a Faraday, a Rutherford and a Bragg.

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sponte circa Gissam nascentium" which gained for him a considerable reputation. The knowledge he showed of cryptogams induced William Sherard to persuade him to come to England mainly to help with the "Pinex" he had undertaken on Tournefort's advice. When Sherard died he left an endowment to found a chair of botany at Oxford stipulating that Dillenius should be its first occupant. The drawings now received cover the whole period of Dillenius's activities, and include a set of copies from published works apparently made in his student days; the coloured figures of the fungi described in the Giessen catalogue; drawings of garden plants from Giessen; those in the third edition of Ray's "Synopsis" (which Dillenius edited) and many prepared and not used; plants found on a Welsh tour in 1726; about 200 of plants growing in the Oxford Botanic Garden, 1744–46; "Junci and Gramina". Most of the material which Vines and Druce mention in "The Dillenian Herbarium" (1907) as having passed into the hands of Prof. Humphrey Sibthorp and eventually disappearing and being "no doubt irrevocably lost" has thus come to light. The drawings show that Dillenius ranks much higher as a botanical artist than was generally thought. It would be highly satisfactory if the numerous letters received by Dillenius from botanical correspondents could be similarly retrieved.

## Astrophysical Monographs

A VALUABLE new series of monographs on astrophysical subjects is being planned by the University of Chicago Press under the auspices of the *Astrophysical Journal*, the editorial board of this journal serving in a similar capacity for the new series. Each monograph aims at being an exhaustive, comprehensive summary of a limited field written by an authority on the subject, and the whole should form a growing library of great use to astronomers and advanced students. In the first monograph ("The Distribution of the Stars in Space". Sup. Roy. 8vo. Pp. xvi+124. Chicago: University of Chicago Press; London: Cambridge University Press, 1937. 11*s.* 6*d.* net), Prof. B. J. Bok deals with stellar statistics and galactic structure, dividing his subject into three sections—the methods of analysis, the data of observation, and problems of galactic structure. In the first section a fuller treatment of the earlier mathematical methods, especially those developed by Charlier and others, would have been welcomed by many if the space had been available, but the necessary condensation has not impaired either the general sequence or clarity of this very readable mathematical section. It has had also the advantage of allowing more complete and critical accounts of modern numerical methods of analysis and their application to determining the distance and absorbing power of a dark nebula. The second section gives a useful summary of the relevant data of observation, and indicates where the need for further observations arises, while the last section deals with general problems of galactic structure of a more or less controversial nature. Although his own views are freely expressed, the author succeeds in giving an impartial and stimulating account of the subject, together with some tentative conclusions suggested as working hypotheses to encourage further observational studies.

## History of Chemistry

WE have received a pamphlet by Prof. E. Pietsch, editor-in-chief of *Gmelins Handbuch der anorganischen Chemie*, which is entitled "Sinn und Aufgabe der Geschichte der Chemie". This is published by Verlag Chemie, Berlin, price 1 mark. Prof. Pietsch shows in a very convincing way the great utility of a study of the history of chemistry in the education of young chemists. He deals with the subject in its cultural aspects and makes clear how such a study can do much to remove the dangers of over-specialization now threatening chemists in the enormous development of minute detail which is occurring in the science. He also shows that a knowledge of past problems can lead to a great economy of time and effort, since in many cases large amounts of time and trouble have been expended on matters which have been fully dealt with before but forgotten. A knowledge of the history of applied chemistry also has a distinct commercial value, examples of which are given. The text includes a very brief but surprisingly complete sketch of the history of chemistry taken as a whole, with its great periods of development. The pamphlet is characterized by a maturity and a philosophical outlook which recommend it to all thoughtful students of science; and to chemists in particular it should prove stimulating and suggestive.

## Midland Naturalists' Union

REPRESENTATIVES of natural history societies in the Midlands meeting in the rooms of the Birmingham Natural History and Philosophical Society on June 18 unanimously decided to form a Midland Naturalists' Union, membership of which is open to natural history, archæological and similar societies in the counties of Monmouth, Hereford, Worcester, Warwick, Leicester, Rutland, Nottingham and Lincoln. It is intended to organize an annual congress, several field meetings and, in larger towns, a number of lectures during the winter months. A list of lecturers willing to visit societies, a panel of referees for specimens and information in the various groups of plants and animals and other branches of natural history and archæology, and a system of lantern slide exchange among members, are also being organized. It is felt that the Union will facilitate co-operative work among the societies as well as bring workers into touch with others in their own branches of the subject. Further information may be obtained from the honorary secretary, G. Brian Hindle, 55 Newhall Street, Birmingham.

## "Dechema"

THE annual meeting of the "Dechema" held in Berlin at the end of April was attended by about 500 people, a testimony both to the interest attached to chemical engineering subjects and to the organizing energy of its director, Dr. Bretschneider. Three reports dealt with standardization, one having relation to technical terms, another to drawings and a third to corrosion from the point of view of rendering

measurements of corrosion made in different laboratories comparable. At the Rome Conference of Chemistry it was agreed that certain questions of chemical standardization should be discussed internationally. A further subject was the possible methods of testing chemical apparatus, which is notably subject to rapid wearing, without destroying it as is usual in engineering practice with test pieces. A second lecture on corrosion dealt with recent efforts to make metal vessels stand up to hydrochloric acid; this is one of the outstanding problems of the chemical industry.

### Dismissals of Scientists in Vienna

IN addition to the scientific workers named in the letter under this title in NATURE of June 18, p. 1101, Miss Margaret Gardiner has received the following further list of dismissals: University of Vienna: Prof. Emil Dittler, mineralogist; Prof. Arnold Durig, physiologist; Prof. Kasimir Graff, astronomer; Prof. Friedrich Kottler, physicist; Prof. Karl Menger, mathematician; Prof. Hans Leitmeier, mineralogist; Prof. Hans Przibram, zoologist; Technical High School: Prof. Alfons Klemenc, chemist; Prof. Wolfgang Johannes Müller, chemist.

### Conference on Elasticity and Plasticity

A CONFERENCE on "Elasticity and Plasticity" will be held under the auspices of the Institute of Physics (Manchester and District Branch) in the Physics Department of the University of Manchester on July 4–5. On July 4 the opening lecture by Prof. G. I. Taylor will take the form of a general theoretical survey, and will be followed by lectures on the elastic properties of metals by Dr. R. W. Bailey, and on the plastic properties of single crystals by Prof. E. N. da C. Andrade. On July 5, lectures will be given by Dr. F. T. Peirce on the elastic properties of fibres, by Dr. J. B. Speakman on the elastic properties of wool, and by Dr. W. G. Wearmouth on the elastic and plastic properties of synthetic resins. Each lecture will be followed by discussion. Visitors will be welcome. Further particulars may be obtained from the Honorary Secretary of the Branch, Dr. W. H. Taylor, Physics Department, College of Technology, Manchester, 1.

### Royal Sanitary Institute

THE Health Congress of the Royal Sanitary Institute will be held at Portsmouth under the presidency of the Earl of Bessborough on July 11–16, when the following subjects among others will be discussed: the future of the general hospital, the defects found in school entrants and the steps to be taken before entering school life, behaviour and nervous diseases in children, food manufacturers' contributions to public health, the Food and Drugs Act 1937, meat and food inspection and air raid precautions. The Health Exhibition arranged in connexion with the Congress will include foods, sanitary appliances, and exhibits illustrating municipal action and hygiene in the home. Further information can be obtained from the Secretary of the Institute, 90 Buckingham Palace Road, London, S.W.1.

### Announcements

THE Committee of the Privy Council for the Organization and Development of Agricultural Research has appointed the Earl of Radnor, lord warden of the Stanneries, chairman of the Lawes Agricultural Trust, and a member of the Council of the Royal Agricultural Society of England, and (after consultation with the president of the Royal Society) Sir Joseph Barcroft, emeritus professor of physiology in the University of Cambridge, and formerly Fullerian professor of physiology in the Royal Institution, to be members of the Agricultural Research Council in succession to Lord Richard Cavendish and Sir Frederick Gowland Hopkins. Sir Thomas Middleton is succeeding Lord Richard Cavendish as chairman of the Council.

PROF. MAX PLANCK, of Berlin, who is an honorary fellow of the Royal Society of Edinburgh, was the guest at a dinner held in his honour in the rooms of the Society on June 23. The president, Sir D'Arcy Wentworth Thompson, was in the chair.

DR. W. H. GEORGE, lecturer in physics at University College, Southampton, has been appointed head of the Department of Physics at Chelsea Polytechnic, in succession to Dr. L. Lownds, who is retiring after thirty-seven years' service.

DR. C. E. FORD, demonstrator in botany, King's College, University of London, has been appointed geneticist to the Government Rubber Research Scheme, Ceylon.

COLONEL CECIL BIRT, late I.A.M.S., who died on March 18, left estate of the gross value of about £35,000. He bequeathed all his property, subject to life interest, to the Library Endowment Fund of the Royal Society of Medicine in appreciation of the services which the library renders to fellows.

The Selborne Society has started a fund for a memorial to the late Lord Leigh, who, during the ten years that he was president of its section which arranges visits to people and places of interest, took an active part in the work of the Society. Mrs. E. M. Richardson Rice, who introduced Lord Leigh to the Selborne Society in the year 1926, has consented to receive contributions at 67 Eardley Crescent, Earl's Court, S.W.5.

PROF. HEINRICH GINS, director of the Robert Koch Institute for Infectious Diseases of Berlin, has been elected an honorary member of the Bulgarian Postgraduate Institute of Veterinary Surgeons.

AN international course in leprosy will be held on July 18–September 17 at the Institute of Malariology in Rome. The lectures, which are intended for foreign medical men, will be delivered in French. Further information can be obtained from the director of the Institute, Prof. G. Bastianelli, Policlinico Umberto 1, Roma.

# Letters to the Editor

*The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 40.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

## Optical and X-Ray Examination and Direct Measurement of Built-up Protein Films

Blodgett, Langmuir and co-workers[1] have described how piles of protein monolayers may be built up on a chromium-plated metal slide by successive vertical movements of the latter through a monolayer spread on a liquid substrate. Following this technique, we have built up from recrystallized egg albumin at its isoelectric point films composed of up to 1,764 monolayers.

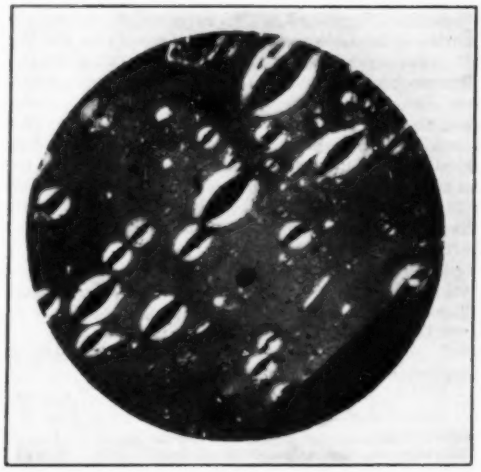
Our first apparatus was operated by hand, but a later design, which will be described in detail elsewhere, was automatic and enclosed, the film being dried for four minutes in a stream of nitrogen after each upward movement.

X-ray examination of even the thickest films *in situ* gave only disappointing results, because of the overwhelming effect of reflections from the metal slide itself; but fortunately it was found that the thicker films could be stripped off, and the way was at once opened up to a variety of experiments.

The first observation of significance was that the films tend to tear parallel to the direction in which the slide was moved through the liquid surface. The next was that, unlike built-up films of barium stearate for example[2], they are birefringent when viewed perpendicular to the surface, and the slow vibration is also parallel to the direction of movement of the slide. The most striking discovery, however, was that our first thicker films show numerous boat-shaped holes—presumably negative tactoids—again all pointing parallel to the direction of movement of the slide, and framed by regions of much higher birefringence still. The accompanying illustration is a photomicrograph between crossed nicols of a stripped film of 1,764 monolayers at 45° to the extinction position. The birefringence of the intact film approaches that of wool, while in the immediate neighbourhood of the holes it is at least as high as that of natural silk (0·05)*. This preliminary optical examination indicates also that the fastest vibration lies in the plane of the film, and the intermediate vibration lies perpendicular to the film.

The most perfect film, of 1,450 monolayers, was built up with the improved apparatus. Its optical properties were similar, but the boat-shaped holes were absent. In compensation, though, it offered a piece of evidence perhaps even more convincing than that of the tactoids—a fringe of delicate, but very real, fibres, once more parallel to the direction of movement!

By dint of repeated folding, stripped ribbons of film were formed into flat, correctly oriented, pads and photographed by X-rays. The photographs correspond to polypeptide chains lying roughly parallel to the direction of movement of the slide, with their side-chains roughly perpendicular to the plane of the film. The dried films are obviously imperfect in the crystallographic sense, whatever they were at the moment of laying down; and they are not composed of 'globular' protein, in the sense of the original egg albumin molecule. The cohesive forces evoked by drying seem to have brought about aggregation at the expense of orientation, as one would rather expect, in view of the fact that the main-chains, and still less the side-chains, of successive monolayers will in general neither fit nor match. The simplest description of the X-ray



photographs so far obtained is that they are analogous to those of keratin that has been squeezed laterally in steam[3]; this treatment not only brings about the α-β transformation, but also tends to orient the side-chains perpendicular to the plane of flattening. Actually, some of the film photographs show more reflections than those of keratin, and there is a distinct hope that with better orientation of the main-chains it may be found possible to determine the amino-acid period.

Two further deductions deserve special emphasis. The first is that since the up-and-down movement of the slide through the monolayer on the substrate has resulted in the deposition of polypeptide chains roughly parallel to the direction of movement, we have here the familiar process of spinning long-chain molecules[4], *and the chains must pre-exist on the surface of the substrate*: there cannot be groups closed more tightly than can be opened and oriented by the movement of the slide. The second deduction is that since there is apparently no thickening of the film round the negative tactoids comparable with the great increase in birefringence, the latter must be due

to more perfect parallelism of the chains; and since the enhanced birefringence agrees with that of oriented polypeptide chains almost devoid of all but the shortest side-chains, namely, those of natural silk, we have a peculiarly satisfying demonstration, quite apart from the X-ray evidence, that the side-chains do indeed tend to lie perpendicular to the plane of the film, as had already been inferred from monolayer studies[5] and from independent X-ray data[6].

Finally, we have succeeded in measuring the thickness per monolayer by direct mechanical means. Our first method was to insert the film under one of the feet of a small three-legged interferometer*, thus altering the angle of an air-wedge included between two pieces of optically flat glass, the upper piece being attached to a balanced metal frame supported by the three legs, and the lower forming the actual table on which rested the film and the three feet. By this means—and it should be noticed that no optical properties of the film itself are invoked—we have measured the thickness of films composed of 600, 800, 1,000, 1,450 and 1,764 monolayers, respectively, and the results all agree in fixing the thickness per monolayer at about 9½ A., and not 20 A., as was first suggested[7]. The value 9½ A. agrees well with the side-chain spacing given not only by the films under discussion, but also by β-proteins in general.

The second method was by way of being a *tour de force*, but it was sufficiently accurate to point once again to a thickness per monolayer of about 10 A. It consisted in measuring the thicknesses of various folded pads of film with a screw micrometer! Needless to say, the thrill of being able for the first time to measure the thickness of a protein chain by such a means far outweighed the satisfaction derived from the more elegant methods.

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FLORENCE O. BELL.

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University of Leeds.

E. GORTER.
J. VAN ORMONDT.

Hospital for Children's Diseases,
Leyden.

June 10.

* For this measurement of the birefringence of silk, and also for collaboration in constructing the small interferometer, we are indebted to Mr. H. J. Woods.

[1] Blodgett, K. M., *J. Amer. Chem. Soc.*, **57**, 1007 (1935); Langmuir, I., Schaefer, V. J., and Wrinch, D. M., *Science*, **85**, 76 (1937).
[2] Blodgett, K. M., and Langmuir, I., *Phys. Rev.*, **51**, 964 (1937).
[3] Astbury, W. T., and Sisson, W. A., *Proc. Roy. Soc.*, A, **150**, 533 (1935).
[4] Cf. the spinning of fibres from denatured globular protein, Astbury, W. T., Dickinson, S., and Bailey, K., *Biochem. J.*, **29**, 2351 (1935). See numerous papers by Gorter, Rideal, and co-workers.
[5] Astbury, W. T., *Trans. Faraday Soc.*, **29**, 193 (1933); NATURE, **137**, 803 (1936); *Chem. Weekbl.*, **33**, 778 (1936).
[7] Langmuir, I., Schaefer, V. J., and Wrinch, D. M., *Science*, **85**, 76 (1937).

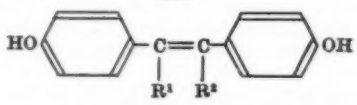
## Œstrogenic Activity of Alkylated Stilbœstrols

IN a previous communication[1] we described the œstrogenic activity of 4 : 4′-dihydroxy-α : β-diethylstilbene (diethylstilbœstrol). It was shown that this substance was fully œstrogenic in doses of 0·004 mgm. given subcutaneously dissolved in oil, and 0·001 mgm. when given by mouth. It is thus several times more potent than œstrone and at least as potent as œstradiol. The following communication is concerned with the activity of a series of compounds in which substituents other than the ethyl group are attached to the α and β carbon atoms. The method of testing was on ovariectomized rats by the usual technique.

Table 1 indicates the results in this series of compounds and gives the potency of the substances in relationship to œstrone. In view of the fact that maximum activity is represented by diethylstilbœstrol, a number of esters of this substance have been prepared and are being tested.

In Table 2 will be found the activity of a series of derivatives of dihydroxydiphenylbutadienes. Here again the maximum activity is present in 4 : 4′-dihydroxy-γ : δ-diphenyl-β : δ-hexadiene. This substance appears to possess an activity equal to that of diethylstilbœstrol. The correspondence in the effects of substituents in the two series is noteworthy and the large effects of relatively small changes may be thought to support our view that the middle section of the molecule conforms to the œstrone pattern when the substituents are ethyl or ethylidene groups.

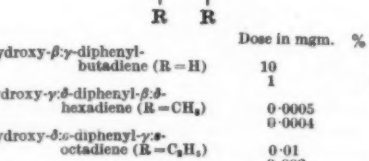
TABLE 1.




| R¹ | R² | Dose in mgm. | % Positive | Units per gram estimated |
|---|---|---|---|---|
| H | H | 5 | 80 | 140 |
| | | 10 | 100 | |
| H | $C_2H_5$ | 0·1 | 50 | 5,000 |
| $CH_3$ | $CH_3$ | 0·02 | 80 | 40,000 |
| | | 0·03 | 100 | |
| $CH_3$ | $C_2H_5$ | 0·0005 | 30 | 1,000,000 |
| | | 0·001 | 100 | |
| $C_2H_5$ | $C_2H_5$ | 0·0003 | 80 | 3,000,000 |
| | | 0·0004 | 100 | |
| $C_2H_5$ | $n$-$C_3H_7$ | 0·001 | trace | 300,000 |
| | | 0·01 | 100 | |
| $n$-$C_3H_7$ | $n$-$C_3H_7$ | 0·01 | 75 | 50,000 |
| | | 0·1 | 100 | |
| $n$-$C_4H_9$ | $n$-$C_4H_9$ | 0·01 | nil | 5,000 |
| | | 0·1 | 40 | |
| Monohydroxy-diethylstilbene | | 0·1 | trace | |
| | | 1·0 | 100 | |

Œstrone administered in oil under the same conditions has activity approx. 700,000 units per gram.

TABLE 2.




| | Dose in mgm. | % Positive |
|---|---|---|
| 4:4′-Dihydroxy-β:γ-diphenyl-butadiene (R = H) | 10 | 100 |
| | 1 | trace |
| 4:4′-Dihydroxy-γ:δ-diphenyl-β:δ-hexadiene (R = $CH_3$) | 0·0005 | 100 |
| | 0·0004 | 70 |
| 4:4′-Dihydroxy-δ:ε-diphenyl-γ:ε-octadiene (R = $C_2H_5$) | 0·01 | 100 |
| | 0·002 | nil |
| β:γ-Di(4-hydroxyphenyl)-α:δ-diphenyl-butadiene (R = $C_6H_5$) | 10 | nil |

The substances mentioned in Table 2 were prepared by dehydration of the appropriate pinacols and the new substituted stilbenes were obtained by applications of the methods previously described.

In the former communication[1] the name of one of us (L. G.) was spelt incorrectly.

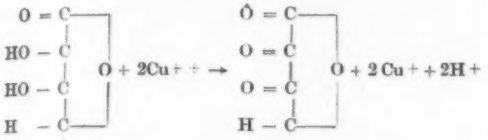
Courtauld Institute of Biochemistry,
Middlesex Hospital, W.1.
Dyson Perrins Laboratory,
University of Oxford.

E. C. DODDS.
L. GOLBERG
W. LAWSON.
R. ROBINSON.

[1] Dodds, Golberg, Lawson and Robinson, NATURE, **141**, 247 (1938).

## Polarographic Estimation of Vitamin C

AQUEOUS solutions of vitamin C when electrolysed at the dropping mercury cathode do not produce any effect on the current-voltage curves. If, however, to a solution of vitamin C—freed from air—a mild oxidizing agent, such as cupric chloride, silver nitrate, gold chloride, ferric chloride or iodine is added, a polarographic 'wave' appears on the current-voltage curve at $-1{\cdot}60$ v. (from the calomel zero). This 'wave' has been shown to be due to the deposition of free hydrions liberated in the solution by the reaction :



ascorbic acid — dehydroascorbic acid (anhydrous form)

This polarographic effect is not specific for vitamin C, as it may be also caused by the presence of other oxidizable compounds like glutathione or cysteine. It is remarkable that the oxidized form of vitamin C, namely, the dehydroascorbic acid, is not electro-reducible at the dropping mercury cathode. It probably changes irreversibly into a hydrated form.

However, a characteristic polarographic effect of vitamin C is obtained, when the dropping mercury electrode is polarized as anode. Then a polarographic 'wave' appears at about $+0{\cdot}3$ v. from the potential of a reversible hydrogen electrode and is shifted according to the *p*H of the solution. For practical purposes it is best to keep the solution at *p*H 7 in an *N*/15 phosphate buffer solution, in which the anodic effect of chloride ions or of glutathione does not interfere with the position of the polarographic 'wave' of ascorbic acid (see the accompanying graph).

ANODIC 'WAVES' DUE TO VITAMIN C.
CURVE 1: PURE *N*/15 PHOSPHATE BUFFER *p*H 7. CURVES 2 and 3: 0·5 AND 1·0 C.C. ORANGE JUICE ADDED TO 4 C.C. BUFFER SOLUTION. CURVE 4: 0·5 C.C. OF 0·01 *M* ASCORBIC ACID ADDED TO 4 C.C. BUFFER SOLUTION.
SENSITIVITY OF THE GALVANOMETER $10^{-7}$ AMP./MM., 1 CM. OF ABSCISSA = 0·2 VOLT.

We have ascertained that vitamin C may be estimated with the usual polarographic sensitivity and accuracy, like hydroquinone[1], that is, down to concentrations of $10^{-4}$ molar, which means 1 γ of vitamin C in the 1 c.c. necessary to carry out the analysis.

As vitamin C is polarographically active only in the reduced form, the analysis should be carried out in absence of air. For that purpose, 0·5–1 c.c. of the fresh lemon or orange juice is added to 4 c.c. of the phosphate buffer (*p*H 7) freed from atmospheric oxygen. If the polarographic curve is recorded shortly after mixing, good results are obtained even in the presence of air.

Extractions from animal tissues, however, offer difficulties, inasmuch as other constituents seem to hinder the electrode reaction.

Full details of this investigation will be published elsewhere.

Department of Zoology and IInd Internal Clinic, Charles University, Prague. May 22.
E. KODÍČEK.
K. WENIG.

[1] Müller, O. H., and Baumberger, J. P., *Trans. Electrochem. Soc.*, **71**, 169 (1937).

## Biological Assay of Vitamin E

THE recent communication from Karrer *et al.*[1] makes it inevitable that comparisons will soon be needed between the biological activities of various substances having the properties of the 'anti-sterility' vitamin. In particular, interest is likely to centre round the relative potencies of the various tocopherols and of synthetic substances. The preparation in these laboratories of a curve relating dosage and response to vitamin E[2] has enabled us to interpret the results obtained with specimens of highly purified tocopherol allophanates, and so to contribute some evidence as to the relative activities of the α- and β-forms, a matter on which the literature contains rather indefinite reports.

In accordance with our practice, we have compared the mean fertility doses of the substances—that is, the doses that will cause 50 per cent of implanted animals to bear live litters. During the test, all conditions are kept as uniform as possible, virgin animals only being used and the doses being divided into ten equal portions and administered every day for the ten days following positive mating. The table below summarizes the results so obtained; the figures for the mean fertility doses refer to weights of tocopherol, calculated from the weights of the allophanates, which were carefully hydrolysed and dissolved in cod liver oil for feeding to the test animals.

| Substance | M.P. | No. of animals used | Mean fertility dose |
|---|---|---|---|
| α-tocopherol | 160° C. | *9 | 1·2 mgm. (weighted) |
| β-tocopherol | 142–3° C. | †6 | 1·9 mgm. |

* At two different dose levels: a still higher dose gave 100 per cent fertility.
† At one dose level: tests at several lower doses gave almost complete sterility.

The specimens of tocopherol were both derived from wheat germ oil concentrates. The highly purified allophanates were prepared by Dr. A. R. Todd, for whose assistance we are very grateful, from crude allophanates supplied by Dr. B. K. Blount, of the Chemical Research Department in these laboratories.

Glaxo Laboratories, Ltd., Greenford, Middlesex. June 16.
A. L. BACHARACH.

[1] Karrer, P., Fritzsche, H., Ringier, B. H., and Salomon, H., NATURE, **141**, 1057 (1938).
[2] Bacharach, A. L., Allchorne, E., *Chem. and Ind.*, **57**, 600 (1938).

## Vitamin E Synthesis of α-Tocopherol

THE recent announcement by Karrer, Fritzsche, Ringier and Salomon[1] makes it desirable for us to place on record the fact that we have also synthesized racemic α-tocopherol by a rather simpler method, namely, direct condensation of phytol with ψ-cumoquinol by heating a mixture of these two substances in presence of a little zinc chloride. This synthesis, like that of the Swiss workers, while it confirms the view originally expressed by ourselves[2] and by Fernholz[3] that the tocopherols are chroman or coumaran derivatives, nevertheless fails to distinguish between the two types of structure.

Karrer's arguments[4] in favour of a coumaran structure for the synthetic product rest on an assumption that phytyl bromide will condense with a phenol in exactly the same way as allyl bromide. This assumption seems to us unjustifiable, and it is indeed more probable that condensations of this type would lead to chroman structures when phytol derivatives are used. Recent degradative evidence, although inconclusive, is on the whole more indicative of a chroman structure for the tocopherols[3,5].

On the synthetic side we have found that 6-hydroxychromans, 5-hydroxycoumarans, and α- and β-tocopherol are nearly identical as regards absorption spectrum, reducing properties, and effect of esterification on absorption spectrum.

We are at present engaged on the synthesis of the tocopherols by unequivocal methods, since it seems that only in this way can a final decision be reached as to their structure.

F. BERGEL.
A. JACOB.
A. R. TODD.
T. S. WORK.

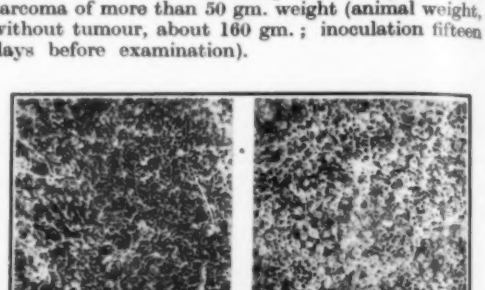
Biochemical Department,
Lister Institute,
London, S.W.1.
June 17.

[1] NATURE, 141, 1057 (1938).
[2] Bergel, Todd and Work, *J. Chem. Soc.*, 253 (1938); Bergel Jacob, Todd and Work, NATURE, 141, 646 (1938).
[3] Fernholz, *J. Amer. Chem. Soc.*, 60, 700 (1938).
[4] Karrer, Fritzsche, Ringier and Salomon, *Helv. chim. Acta*, 21, 520 (1938).
[5] Dietzel, Günther and Emte, *Naturwiss.*, 366 (1938).

## Formation of Hæmolymph-Glands in Tumour-Bearing Rats

A CHANGE has been observed in the appearance of the lymph-glands of rats bearing a Jensen sarcoma, the animals being examined usually fifteen to eighteen days after the subcutaneous inoculation of the tumour. While the lymph-glands of normal rats were found to be almost entirely of a light yellowish colour, a more or less large number of the lymph-glands of the tumour-bearing rats showed, to a varying extent and degree, a red discoloration. The change occurred in glands of all regions, although unequally, and in an irregular manner in different animals. The size of the tumour and the age of the animal, within the given limits, appeared to have little influence.

Microscopical examination of these lymph-glands showed that a conversion into more or less pronounced hæmolymph-glands had taken place. The normal lymph-tissue had to a varying extent disappeared. Its place was, in the first instance, taken by red blood corpuscles, which were more or less densely aggregated. Among them could be observed, in most cases, a considerable number of particularly large, sometimes pigmented cells, probably the descendants of normal (non-lymphocytic) tissue cells. The whole of this structural change is evident from a comparison of the accompanying illustrations. In each is illustrated part of a section through a lymph-gland taken from the left axilla of a female rat, (*a*) referring to a normal animal (weight about 170 gm.) and (*b*) to an animal bearing, at the right side, a sarcoma of more than 50 gm. weight (animal weight, without tumour, about 160 gm.; inoculation fifteen days before examination).



(*a*) (*b*)

STRUCTURE OF A LYMPH-GLAND, (*a*) FROM A NORMAL RAT, (*b*) FROM A TUMOUR-BEARING RAT. HÆMATOXYLIN—EOSIN. (× 120).

The simplest explanation of the origin of this change appears to be that it is due to the action of a certain substance produced by the growing tumour cell. Investigations with the aim of finding out the chemical nature of this substance are now in progress. In this connexion it is of interest to note that a similar change was previously observed in the lymph-glands of rats which had received a series of subcutaneous injections of a preparation of carcinogenic tar[1]. Further, it is important that Clarkson, Mayneord and Parsons[2] have obtained a corresponding result with the lymph-glands of animals which had been irradiated with X-rays. In addition, the authors mentioned that a derivative of 1 : 2 : 5 : 6-dibenzanthracene was likewise capable of producing the change.

A. LASNITZKI.
M. LASNITZKI.

Cancer Research Department,
University of Manchester.
June 2.

[1] Lasnitzki, A., *J. Hygiene*, in the press.
[2] Clarkson, J. R., Mayneord, W. V., and Parsons, L. D., *J. Path. and Bact.*, 46, 221 (1938).

## Kallikrein as a Reynals Factor

THE spreading or diffusing factors, also termed Reynals factors or shortly *R.* factors, after F. Duran-Reynals[1], who found these factors in watery extracts of testicle of mammals, are endowed with the property of enhancing tissue permeability. When indicators, such as Indian ink, trypan blue or diphtheria toxin are added to such extracts and a certain amount of the mixture is injected intracutaneously in rabbits, an extensive spread of the particles of Indian ink, trypan blue or the toxin takes place, resulting in much larger coloured or inflamed areas than can be obtained by mixing other substances (excluding the few other *R.* factors) with the indicators. As a control in experiments with *R.* factors a mixture of 0·9 per cent sodium chloride with the indicator is generally used.

Duran-Reynals has found the *R.* factors in lesser amounts in several other organs. D. McClean[2] found the factors in certain anaerobic bacteria. E. Boyland and D. McClean[3] showed the existence in relatively great amounts of spreading factors in malignant transplantable tumours, in embryos and in placenta. A. Claude[4] demonstrated the factors in leech extract, especially in extracts of the head of the leech.

Recently, *R.* factors were found constantly present in human urine (J. F. Christensen[5]). In a search for the substance responsible for the spreading effect of urine, an examination was made of Kallikrein, which was found in repeated experiments to be as active as, or even more active than, the *R.* factor from testis in spreading properties. An example will illustrate this: Solutions containing 30 mgm. of Kallikrein per c.c. and 3 mgm. Kallikrein per c.c. and solutions of the same concentrations of a purified testis extract were prepared. To these solutions and to a control solution of 0·9 per cent sodium chloride were added equal amounts of diphtheria toxin diluted 1–1,000, 0·25 of each solution was injected intracutaneously in rabbits, in the shaved skin of the back.

With the Kallikrein solutions, the areas of inflammation produced were 47·8 cm.² and 33·9 cm.² respectively. With testis extract the areas obtained measured 29·6 cm.² and 21·1 cm.² respectively. The control area: 5·6 cm.². Measurements were made 24 hours after injection.

Titrations to the end-point are being carried out. A new method for standardizing Kallikrein seems possible.

The identity of the various *R.* factors has never been established and little is known of their chemistry. In all known respects—solubility, precipitability, sulphur reaction, diazo-reaction, non-diffusibility and nitrogen content—Kallikrein is in accordance with the testis factor. It seems as if testis extract (*R.* factors) has not been examined for blood-pressure lowering effect. As the preparation of *R.* factors from testis by the methods used hitherto involves at least a contamination with activated Kallikrein from the blood content of the organ, a blood-pressure lowering effect of the *R.* factor preparations from testis may be expected.

Details and further experiments will be published shortly.

J. F. CHRISTENSEN.

Radiumstationen for Jylland,
Aarhus, Denmark.
June 1.

[1] Duran-Reynals, F., *J. Exp. Med.*, **65**, 661 (1937).
[2] McClean, D., *J. Path. and Bact.*, **42**, 457 (1936).
[3] Boyland, E., and McClean, D., *J. Path. and Bact.*, **41**, 553 (1935).
[4] Claude, A., *J. Exp. Med.*, **66**, 353 (1937).
[5] Christensen, J. F., *Hospitalstidende*, **81**, 572 (1938).

## Intense Radioactivity of the Superficial Ocean Floor

IN connexion with a recent discussion on the relation of the existing degree of terrestrial isostasy to the broken stratification that often accompanies it[1], a report of delicate investigations of core samples of some length taken from the mud of the deep ocean bottom (where there is excess of isostasy by stretching[2]) initiated and carried out for some years with great ingenuity by the Carnegie Geophysical Laboratory at Washington, D.C., thus exposing the course of recent geological history, and especially the excessive radioactivity (already somewhat in evidence) revealed in these superficial soft cores, is a development not to be overlooked[3].

The early results of the present Lord Rayleigh, Dr. Joly, and others had shown that if the radium content of the surface rocks were to continue undiminished downward towards the centre of the earth the generation of heat arising from its degradation alone would be far in excess of the observed total output of terrestrial heat at the surface. It has to be presumed, therefore, that when the earth's contents settled down originally into a planet, the deposition of uranium, the parent of radium, in the central parts was prohibited, by some agency which it is for the chemists to explore, so that it was gradually pushed up towards the surface. The point now to be made is that this would be quite in keeping with Dr. Piggot's ingenious and interesting theory, that it is to the chemical interactions endured by the uranium in the oceanic waters that the excessive deposit downward of uranium, and therefore of the more transient radium, which is found on the outer skin of the oceanic floor, must be traced[4]. This additional indication towards the ways in which the various features of the geophysical landscape, such as stratigraphy, isostasy, radioactivity, can unexpectedly interlock must here suffice.

JOSEPH LARMOR.

Holywood,
N. Ireland.
May 30.

[1] NATURE, **141**, 603, 906 (1938).
[2] Note that the hyper-isostasy, and the stretching that has thinned the ocean bed, and its depression which could not be primeval, are here all correlated.
[3] Piggot, C. S., "Core Samples of the Ocean Bottom and their Significance", in recent "Papers from the Geophysical Laboratory".
[4] It is reported that investigation as to the total depth of the deposit is now in progress at Cambridge by E. C. Bullard.

## Micro-Organic Rock Weathering

THE following results obtained in 1922 by the late Sir John Harrison, formerly director of science and agriculture in British Guiana, may interest pedologists. They represent the chemical composition of percolated water that had passed through sterilized granular masses of dolerite and of granite packed into four glass cylinders set up in the laboratory. In two experiments, the materials were inoculated with washings from the surfaces of weathering rock of the same kind; in the other two, the conditions throughout were sterile.

The comminuted rock, passing a 40 mesh to the inch sieve, but not a 100 mesh sieve, weighed about one kilogram in each experiment. Sterilized water was added to each cylinder every other day on twenty-five occasions. The volume of the collected drainings in each experiment was 1,600 c.c., the rate of percolation being adjusted to 13 c.c. per hour during the successive 5-hour periods of the treatment. The rock grains were thus intermittently covered with stationary water-films for a total period of 1,075 hours.

The chemical analyses were performed by Mr. G. C. L. Bourne, assistant chemist in the British Guiana Department of Agriculture; thanks are due to him for abstracting the data from Sir John Harrison's posthumous records, and to Prof. J. S. Dash, director of agriculture, for permission to publish them.

The degree of hydrolytic weathering is greater (by 33 and 19 per cent respectively) for the inoculated rock materials; the increases mainly concern calcium and magnesium among the basic radicals,

and carbonate (or bicarbonate) among the acidic radicals. Ferrous iron seems to have been oxidized to ferric in the inoculated materials.

ANALYTICAL RESULTS (EXPRESSED IN PARTS PER MILLION)

| Radical | Dolerite | | Granite | |
|---|---|---|---|---|
| | Sterile | Inoculated | Sterile | Inoculated |
| K .. .. | 10·6 | 14·6 | 16·9 | 14·1 |
| Na .. .. | 33·6 | 48·0 | 29·3 | 24·5 |
| Ca .. .. | 47·7 | 69·5 | 13·3 | 33·4 |
| Mg .. .. | 12·6 | 20·8 | 2·0 | 3·4 |
| Fe (ous) .. | 2·9 | 0·8 | 4·3 | 1·4 |
| $CO_3$ .. .. | 64·6 | 134·8 | 63·7 | 93·0 |
| $SO_4$ .. .. | 154·7 | 150·1 | 21·5 | 14·4 |
| Cl .. .. | 1·7 | 1·6 | 1·9 | 1·6 |
| $SiO_3$ .. .. | 11·1 | 10·9 | 12·5 | 11·1 |
| Salinity .. | 339·5 | 451·1 | 165·4 | 196·9 |
| per cent increase .. | | 33 | | 19 |

That micro-organisms may be involved in rock weathering had previously been suggested by Sir Thomas Holland in his account of the origin of laterite in the humid tropics[1]; other authorities have more recently suggested that they might also be involved in the decay of building stones.

F. HARDY.
Imperial College of Tropical Agriculture,
Trinidad.
May 4.

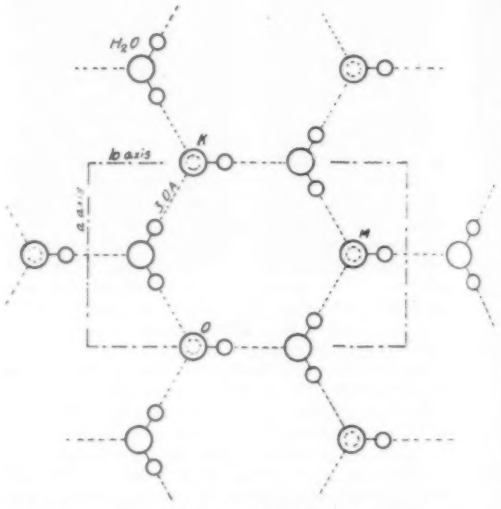
[1] *Geol. Mag.*, **10**, 59–69 (1903).

## Crystal Structures of the Clay Mineral Hydrates

THE manner in which water is adsorbed on clays has long been a matter for speculation. Structure determinations for the clay mineral hydrates throw new light on this question. These hydrates are the minerals vermiculite, hydrated halloysite and montmorillonite. Their compositions, subject to isomorphous replacements, are $(OH)_4Mg_6Si_8O_{20}.8H_2O$; $(OH)_8Al_4Si_4O_{10}.4H_2O$; and $(OH)_6Al_4Si_4O_{20}.nH_2O$, respectively. Each structure contains sheets formed by joining tetrahedra of oxygen atoms around silicon atoms into interlocked hexagonal groupings as first described by Pauling[1]. These are combined with octahedra of oxygen atoms and hydroxyl ions about magnesium and aluminium ions, forming layers the compositions of which in a unit are given by the above formulæ.

It is now shown that such hydrates contain layers of water molecules as illustrated in the accompanying figure, and that these are interleaved with the silicate structure. Their stability derives from the attraction between hydrogen atoms of one water molecule and oxygen atoms of other water molecules, after the manner of hydroxyl binding as described by Bernal and Megaw[2]. Since each side of a hexagon corresponds to a single hydrogen atom, hydrogen atoms of half the water molecules, *K*, *M* and *O*, of the figure, must be directed away from the net. These bind the water network to oxygen atoms in the top of the silicate layer, there being similarly placed oxygen atoms in that layer. In vermiculite there are two such sheets of water molecules between the silicate layers, the upper and lower surfaces of which are formed of oxygen atoms. Hydrated halloysite, on the other hand, has but a single sheet since hydroxyl groups form the bottom of the silicate layer[3].

Montmorillonite, the swelling clay, also probably forms hydrates of this type. Information in the literature is misleading in that it indicates (*a*) too great an amount of water and (*b*) a continuous change of (001) spacing with water content. In the first instance, the total water is not a measure of the amount between the layers since it includes surface adsorption, which is also of the sheet type. Continuous change of spacing does not mean a continuously varying separation of layers, but can as well arise from random combination of a few definite values corresponding to 0, 2, etc., sheets of water molecules per silicate layer.




This hexagonal network of water molecules is somewhat related to the hexagonal rings of hydroxyl groups in boric acid, $H_3BO_3$[4]. It more closely resembles the hexagonal ring of water molecules in $(CH_3C\,NH)_2.3H_2O$, which is the hydrated polymer of 'acetaldehyde ammonia'[5]. However, the clay mineral hydrates differ from this compound in that the oxygen atoms form an hexagonal network in which they are quite closely coplanar.

STERLING B. HENDRICKS.
U.S. Bureau of Chemistry and Soils,
Washington, D.C.
May 28.

[1] *Proc. Nat. Acad. Sci.*, **16**, 578 (1930).
[2] *Proc. Roy. Soc.*, A, **151**, 384 (1935).
[3] Hendricks, *Am. Mineralogist*, **23**, 295 (1938).
[4] Zachariasen, *Z. Krist.*, **88**, 150 (1934).
[5] Moerman, *Z. Krist.*, **98**, 447 (1938).

## Model Experiments on the Minimization of Structural Vibrations caused by Seismic Disturbances

EVEN should the design of earthquake resistant structures be based on stiff constructions, resistant even under resonance against seismic vibrations of relatively low frequencies, it has not been possible as yet to average out the pronounced peaks in the seismic vibration curves of resonances; in the seismic vibration the amplitude is particularly large in the horizontal direction and the vibration of structures is most sensible for the horizontal movement of the foundations. Experiments have been made therefore on the horizontal movement of a model foundation-table. After several experiments with different

conditions of loading, it was found that vertical loads placed on a group of shot (ball or spheres of equal diameter) are very effective as a practical method of flattening the resonance curve; the load on the shot acts as a very good damper of the vibration, and is more effective the nearer to the roof it is placed.

Fig. 1 shows the free vibration curve of a frame structure (4 × 20 cm. = 80 cm. high, 20 cm. bay and 1 cm. thick), the load conditions and period of which are indicated in the figure. Fig. 2 shows the same free vibration

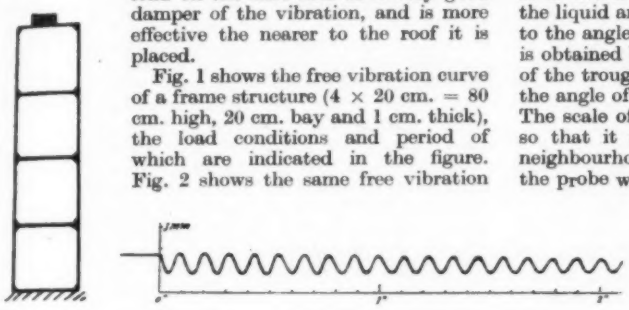


Fig. 1.

DIRECT LOAD, 435 gm.; DEAD LOAD, 860 gm.; PERIOD, 0·125 sec.

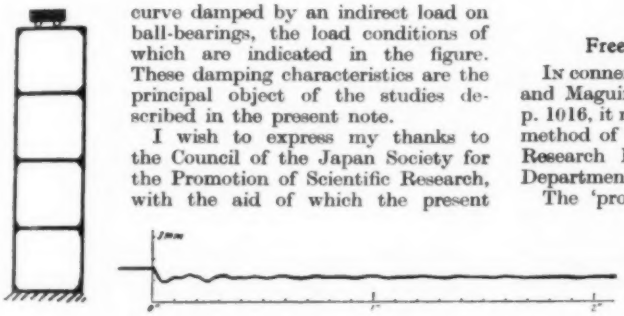


Fig. 2.

INDIRECT LOAD ON BALL-BEARINGS, 400 gm.; WEIGHT OF BALL-BEARINGS, 35 gm.; DEAD LOAD, 860 gm.

curve damped by an indirect load on ball-bearings, the load conditions of which are indicated in the figure. These damping characteristics are the principal object of the studies described in the present note.

I wish to express my thanks to the Council of the Japan Society for the Promotion of Scientific Research, with the aid of which the present investigation, including some hundred model experiments of a similar kind, has been made possible.

F. TAKABEYA.

Hokkaido Imperial University,
Sapporo.

## Electrolytic Field Plotting Trough for Circularly Symmetric Systems

THE method of plotting electrostatic equipotentials between conductors by measuring the potentials in a geometrically similar problem in conduction is very old and well known. We have applied this to a modified form of electrolytic trough which we have been using in this laboratory for the past four years. This has been specially designed for circularly symmetric systems.

It is always permissible in problems of conduction to introduce along any surface an insulating barrier across which there is no flow of current. We have applied this to circularly symmetric systems by cutting the system along two diametrical planes, thus obtaining a liquid wedge. Such a wedge is realized in practice by a tilted trough containing electrolyte resting on a plane insulating bottom. If the angle of the wedge is small, the electrodes used in it need not be surfaces of revolution but can be replaced by pieces of metal sheet bent to the shape of a longitudinal section of the actual electrode.

A trough of the type described gives very satisfactory results if a few minor precautions are taken. It is necessary to produce a contact angle between the liquid and insulating bottom which approximates to the angle of the wedge as nearly as possible. This is obtained by allowing the liquid to wet the bottom of the trough only up to the axis. Then by reducing the angle of tilt the desired contact angle can be got. The scale of the system is made as large as possible so that it is unnecessary to plot the field in the neighbourhood of the axis where capillary rise on the probe would introduce serious error. In addition to the above-mentioned precautions it is, of course, necessary to observe all the usual points in working with an A.C. electrolytic bridge.

M. BOWMAN-MANIFOLD.
F. H. NICOLL.
Research Laboratories,
Electric and Musical Industries, Ltd.,
Hayes, Middlesex. May 27.

## Free Field Calibration of Microphones

IN connexion with the contribution by Messrs. King and Maguire to this subject in NATURE of June 4, p. 1016, it may be of interest to refer to a very similar method of calibration which has been in use by the Research Branch of the Post Office Engineering Department since 1933.

The 'probe tube' device to which I refer[1] is so constructed that reflections of sound in the tube are practically eliminated. This means that the acoustical impedance presented by the open end of the tube is substantially non-reactive. The open end can therefore be exposed at one of the closed ends of the resonant air column which is used for calibrating, without affecting the positions of the nodes and anti-nodes in the stationary wave system set up in the air column. The air particle velocity is measured by a Rayleigh disk located at the centre of the air column at any frequency of resonance at which the length of the column is an odd multiple of half a wave-length, and the sound pressure at the end of the column, that is, at the open end of the probe tube, is thus known. Since the tube is small, the calibration is the same as a free field calibration.

With an air column about seven feet in length, calibration can be effected at more than forty values of frequency, extending from 80 to more than 6,400 cycles per second, without any readjustment of either the length of the air column or the position of the probe tube.

The absence of resonance in the probe tube enables the device to be used for measuring sound pressures at a point, not only in an unobstructed sound field, but also at the surfaces of solid obstacles or near the openings of resonators, without appreciably altering the pattern of the sound field.

W. WEST.

Post Office Research Station,
Dollis Hill,
London, N.W.2.
June 13.

[1] West, W., *Post Office Elec. Eng. J.*, **26**, 260 (Jan. 1934).

## Relativity and the Speed of Light

THE hypothesis that light always seems to have the same speed in spite of relative motion of source and observer can be tested directly by measuring the speed of light received from approaching and receding stars. This measurement can be made with high accuracy and a very short light path by W. C. Anderson's development of the Kerr cell method[1]. Anderson's apparatus can be used at the eyepiece of coudé or polar telescopes, and might perhaps be adapted for mounting on equatorials.

If light from a star in motion $\pm v$ relative to the earth has speed $c$, the hypothesis will be proved; but if the light has speed $c \pm v$, the hypothesis will be upset and the Michelson-Morley result very simply explained. Only actual measurement can decide, and it is surprising that relativity enthusiasts have not asked for the experiment to be tried.

F. H. C. SMITH.

Stratford Road,
Birmingham.
June 9.

[1] *Rev. Sci. Inst.*, **8**, 239 (July 1937); summarized *Sci. Prog.*, **32**, 713–17 (April 1938).

## Combined Ascorbic Acid in Plant Tissues

THE letter from Guha and Sen-Gupta recently published in NATURE[1] prompts us to give very briefly the results of some of our own experiments. The technique we have used is based on that described for urine[2]. We find that in cauliflower juice (to quote one experiment) the total indophenol reducing substances amount to about 0·280 m.mol per 100 ml. Of this, free ascorbic acid accounts for some 0·007 m.mol, dehydroascorbic acid for 0·110 m.mol, and combined ascorbic acid (liberated by acid hydrolysis) for 0·150 mol. The non-ascorbic acid reducing substances are almost entirely in the combined form (liberated by acid hydrolysis) and amount to only 0·012 m.mol per 100 ml. of juice. The combined ascorbic acid is non-dialysable and is incompletely precipitated when the proteins are removed by metaphosphoric acid.

HAROLD SCARBOROUGH.
C. P. STEWART.

Clinical Laboratory,
Royal Infirmary,
Edinburgh.
June 14.

[1] Guha and Sen-Gupta, NATURE, **141**, 974 (1938).
[2] Scarborough and Stewart, *Biochem. J.*, **31**, 2232 (1937).

## Points from Foregoing Letters

Dr. W. T. Astbury, Miss Florence Bell, Prof. E. Gorter and Dr. J. van Ormondt have built up protein films composed of up to 1,764 monolayers of egg albumin, and having observed that such films may be stripped from their metal base, have examined them optically and by X-rays, and measured their thickness by direct mechanical means. The thickness per monolayer is about 9½ A., agreeing with the X-ray patterns and previous indirect estimates, and the structure is one of polypeptide chains lying roughly parallel to the direction of movement of the slide, with the side-chains roughly perpendicular to the surface. They infer that polypeptide chains pre-exist in the monolayer on the liquid substrate.

A table showing the œstrogenic activity of several derivatives of stilbœstrol is submitted by Prof. E. C. Dodds, L. Golberg, W. Lawson and Prof. R. Robinson. One of these synthetic compounds, 4 : 4′-dihydroxy-γ : δ-diphenyl-β : δ-hexadiene has an activity several times that of the sex hormone, œstrone, and equal to that of diethylstilbœstrol, a synthetic compound previously investigated.

Vitamin C (ascorbic acid) produces a characteristic 'polarographic curve', with a dropping mercury electrode polarized as anode. The effect may be used, according to E. Kodíček and K. Wenig, for the estimation of small amounts (1 γ) of ascorbic acid in orange and lemon juice but not in extracts of animal tissues.

Determination of the relative vitamin E activity of α- and β- tocopherol, separated as allophanates from wheat germ oil, is discussed by A. L. Bacharach. The β form has a somewhat greater antisterility action.

Dr. F. Bergel, A. Jacob, Dr. A. R. Todd and T. S. Work state that they have synthesized α-tocopherol by a simpler method than that employed by Karrer and co-workers, namely, by the direct condensation of phytol with ψ-cumoquinol. The authors consider that the tocopherols have a chroman rather than a coumaran structure.

In rats bearing a Jensen sarcoma, Drs. A. and M. Lasnitzki have found a conversion of normal lymph-glands into more or less pronounced hæmolymph-glands. A similar change has been observed in animals which had received injections of carcinogenic tar.

'Kallikrein' injected in the skin of rabbits together with extract of testis is found by Dr. J. F. Christensen to increase the area of inflammation, as compared with the effect of extract of testis alone. This indicates that Kallikrein acts as a diffusing or 'Reynals' factor, that is, one which increases the permeability of tissues.

Sir Joseph Larmor directs attention to the greater radioactivity of the ocean floor, a fact explained by Piggot as due to the precipitation of uranium, parent of radium, from the ocean water. Rayleigh and Joly have calculated that the amount of radium at the surface of the earth must be greater than in the interior. These facts, Sir Joseph considers, are connected with the problem of terrestrial isostasy.

Results obtained by the late Sir John Harrison, showing that water containing micro-organisms attacks granulated rocks (granite and dolerite) more rapidly than ordinary water, are submitted by Prof. F. Hardy.

According to Dr. S. B. Hendricks, hydrates of the clay minerals contain layers formed by association of water molecules into hexagonal networks. Adsorbed water on these and related layer minerals such as micas, chlorites, talc, etc., is also probably of this type.

Prof. F. Takabeya finds that a load supported on balls or spheres of equal diameter and placed near the top of a frame structure is very effective in damping vibrations.

The calibration of a probe tube device for measuring sound pressures in air is described by W. West. The tube is non-resonant and can be used for measuring sound pressures near solid surfaces as well as in an unobstructed sound field.

# Research Items

### Mesolithic Site at Piscop (Seine-et-Oise)

A MESOLITHIC site at Piscop (Seine-et-Oise) discovered by M. E. Giraud in 1930, has been excavated over a period of five years by MM. Giraud, C. Vaché and E. Vignard (*L'Anthropologie*, **48**, 2–3; 1938). The site is situated on a slope of the Montmorency plateau. Stratification downward is as follows: (1) humus, 10–15 cm. thick, dark grey in colour, with a neolithic industry; (2) sandy soil, 20 cm.–1·8m. thick, or more or less grey, with a mesolithic industry; (3) blackened indurated sand with a few objects of Upper Palæolithic date; (4) Fontainebleau sands of tertiary age, ochre yellow, sterile. In (1) no neolithic object was found at a depth greater than 15 cm. In the deposits of (2) the surface of the occupation level had been irregular. It also showed depressions and pits, the latter it was inferred from the contents being the remains of semi-subterranean dwellings. Smaller excavations may have been burials, though no bones, but only a considerable number of flakes and implements, were found in them. Four hearths were located and quantities of well-preserved charcoal, in which were implements of flint showing the action of fire. In all, 2,909 implements were found, of which 1,193 are classified as micro-burins, 422 as Tardenoisian 'pointes', 206 as triangular or scalene, and 243 as segments of a circle. Occupation of the site extended over a considerable period of time. Two phases are to be observed—an earlier, contemporary with the proto-Tardenoisian Sauveterrian, and a later, in which the Tardenoisian industry is accompanied by some hundreds of implements of sandstone, of which the *pic-plane* is characteristic, occurring for the most part on the habitation sites, and none at a depth greater than 70 cm. These *pic-plane* implements suggest (1) a greatly increased activity in wood-working and (2) that the Tardenoisian tribes, essentially mobile, used implements heavier than their hunting equipment when settling down for any length of time. Their occurrence here in conditions which made their pre-Campignian dating certain, show that this class of implement is older than has been thought, and contributes to discussion of the occurrence of Tardenois and neolithic together.

### Diagonal Law of Birth-Rate Decline

IN a statistical study of the decline in the birth-rate in various European countries, by Mr. R. S. Barclay and Dr. W. O. Kermack (*Proc. Roy. Soc. Edin.*, **58**, 55; 1938), several significant facts are brought out. It is first shown that for Scotland since 1860 and for England and Wales since 1841, when age at death began to be recorded, the specific death-rates in each age-group decrease at a constant rate for each age-group, giving what is called the diagonal law. The same method is then applied to birth-rates. This cannot be applied to Great Britain because the age of the mother at each birth has only just begun to be recorded. But from birth-rate data of Sweden, Denmark and Finland, when the specific fertility rates for any age-group (except 15–20) are expressed as percentages of a standard rate before the fall in the birth-rate began, these percentages also conform to a diagonal law. This holds approximately for both the total fertility rates and the legitimate fertility rate. The diagonals for death-rates and birth-rates are, however, at right angles, which means that the decline in fertility first began with the older women while the decline in mortality affected first the younger age-groups and then spread upwards. The wave of reduced fertility passes from one quinquennial age-group of women to the next in five years. The same linear relationships are indicated in Norway and France, but marked deviations occurred in all countries during and immediately after the Great War. This diagonal law is applied in predicting the fertility rates in England and Wales until 1951.

### A New Strepsipterous Insect

MR. T. W. KIRKPATRICK, of the Amani Research Station, Tanganyika Territory, has published a notable paper on the above subject (*Trans. Roy. Entom. Soc. Lond.*, December 1937). The insect in question, *Corioxenos antestiæ* Blair, parasitizes coffee bugs of the genus *Antestia* after the manner of a stylops. Since the work of the Russian observer, Nassonov, published in 1892–93, very little has been added to what is known of the biology of Strepsiptera. Knowledge is especially meagre of those forms which 'stylopize' Hemiptera, and Mr. Kirkpatrick's paper provides the only detailed account available of the biology and metamorphosis of a form which parasitizes members of this order. It is well known that the hosts of Strepsiptera often differ in their external characters from unstylopized examples, but *Corioxenos* produces no such effects. Its influence on the internal sexual organs, however, is very marked: female hosts are invariably infertile and the males are usually so. The male *Corioxenos* passes through eight instars before becoming adult, and each of them is figured and described. The adult male only lives for two to three hours, but during that time it is able to pair with a number of females. The females produce more than 3,500 triungulins apiece during a period of about three months.

### Chilopoda of New Zealand

THE Chilopoda or centipedes of New Zealand form the subject of a revisional monograph by Mr. G. Archey, who is director of the Auckland Museum, N.Z. (*Rec. Auck. Inst. Mus.*, **2**; 1936–37). Prior to the completion of this study, some 64 species of New Zealand Chilopoda had been named. The results of the present work, instead of adding to this list, have entailed the reduction of this number to 37 species. This reduction has resulted from the examination of many specimens of several of the species, which with a study of those characters hitherto regarded as of diagnostic value, has shown that such features fall within the normal range of variation of widely distributed species. Only a single new species is described. As regards their zoo-geographical relationships, the New Zealand centipedes appear to be more closely akin to those of southern Australia than elsewhere.

### Absorption of Gas Bubbles in Wood Vessels

H. Dickson and V. H. Blackman have recently published experimental observations on the absorption of bubbles of air, nitrogen and oxygen introduced into the xylem vessels of both living and dead tissues of *Impatiens parviflora* (*Ann. Bot.*, New Series, 2, No. 6, 293; April 1938). The bubbles were found to decrease in size until they were dissolved in the cell-sap of the surrounding tissues. Rate of absorption varied, the average-sized bubble taking 12–20 minutes to be completely absorbed. The disappearance of these artificially introduced air bubbles is attributed mainly to the increased partial pressures of the gases of the bubbles resulting from the high surface tension forces acting on the small bubbles. No evidence was obtained to support the suggestion (P. K. Sen and V. H. Blackman, *Ann. Bot.*, **47**, 663; 1933) that increase in the partial pressure of nitrogen in the bubbles, resulting from the absorption of oxygen by the surrounding living tissues, plays any part, though the authors state that some such effect would seem inevitable. The bearing of these results on the ability of cut flower shoots to absorb water, after the cut surfaces of their stems have been exposed to the air, is discussed.

### Magnetic Susceptibility of Iron in Ferrohæmoglobin

THE iron in oxyhæmoglobin and carbon monoxide hæmoglobin is diamagnetic and the iron atom is bonded to six neighbours with covalent bonds. The iron atom in ferrohæmoglobin has a magnetic moment about equal to that expected for a ferrous ion held by electrostatic bonds but somewhat larger than usual for ionic ferrous complexes. With the technique now in use, hæmoglobin concentrations can be measured as accurately by magnetic methods as by the more tedious gasometric methods. D. S. Taylor and C. D. Coryell (*J. Amer. Chem. Soc.*, **60**, 1177; 1938) have determined the magnetic susceptibilities per formula weight of iron in hæmoglobins as: cow, 12,290; horse, 12,260; sheep, 12,390; human, 11,910; all $\times 10^{-6}$ C.G.S. units at 25°. The magnetic moments for the hæmoglobins are calculated as 5·435, 5·43, 5·46 and 5·35 Bohr magnetons, respectively, assuming independent iron atoms. In an extensive study of cow hæmoglobin the susceptibility was found to be constant from individual to individual and to be unaffected by hæmolysis. Normal blood and oxyhæmoglobin solutions contain hæmoglobin-like compounds, probably containing ferric iron, which do not combine with oxygen. It was established that the hæmoglobin concentration determined from the carbon monoxide capacity after reduction agrees with that determined from the iron content. The accurate determination of the paramagnetic susceptibility of the iron in hæmoglobin now makes it possible to determine hæmoglobin concentrations magnetometrically with high precision.

### Arrangement of Molecules in Mono- and Multi-Layers

IN an extension of their investigations of the arrangement of molecules in mono- and multi-layers, L. H. Germer and K. H. Storks (*J. Chem. Phys.*, **6**, 280; 1938) record observations by electron diffraction methods on layers of stearic acid and of barium stearate deposited on a chromium-plated surface, and by electron transmission methods on layers of the same substances deposited on a thin foil of 'Resoglaz'. When the chromium-plated block is dipped through a monolayer of either substance, a single layer of the substance is deposited on the chromium surface. The hydrocarbon chains of such a layer are closely packed but arranged irregularly, and the axes of the chains are practically normal to the surface. On each subsequent dipping of the block, *two* layers are deposited, and in these layers the molecules are regularly arranged in a characteristic crystal unit with chain axes normal to the surface. When 'Resoglaz' is dipped through mono-layers, each dipping, including the first, results in the deposition of two layers, and the molecules are always arranged regularly in the characteristic crystal unit. On 'Resoglaz' the hydrocarbon end of the molecule is in contact with the support, whereas it is the barium or the carboxyl group which makes contact with the chromium. Deposition of stearic acid on polished steel indicates an irregular arrangement of molecules in the first layer. Presumably this irregularity in the first layer on a metal surface is due to interaction between the stearic acid and the metal. The paper contains an interesting suggested extension of these methods to the investigation of boundary lubrication. Another predicted extension is to the investigation of layers of adsorbed gas.

### Measuring Bridge for Conductimetric Titrations, etc.

WE have had an opportunity of using one of the measuring bridges, Type *G.M.* 4140, designed by the Mullard Wireless Service Co., Ltd., 225 Tottenham Court Road, W.1. This is a very compact instrument made up in a strong metal box, the cost being £12 12s. With connexions to the mains and an earth, resistances from 0·1 ohm to 10 megohm can be measured directly with the mains frequency of 50 cycles. The balance point is very ingeniously read visually by means of an electron beam tube in conjunction with a high-magnification pentode valve. This arrangement gives very clear and sharp balance points, and the absence of galvanometers or telephones makes the whole lay-out most compact and handy. The electron beam indicator can be made very sensitive near the point of balance. Several conductimetric titrations with various substances were made with a cell also supplied by the makers of the instrument, and it was found possible without any difficulty to attain an accuracy of 1 per cent, this accuracy being limited by the scale reading and adjustment by the milled head carrying a pointer. It would be possible to increase the accuracy somewhat by a fine-adjustment screw and vernier. The results were equally good with low and high resistances. The bridge potential is only 1 volt and hence it is probable that even with a frequency so low as 50 cycles per second, there is no appreciable polarization error in normal cases, when this voltage does not exceed the decomposition voltage of the electrolyte used. With silver nitrate solution and silver electrodes, we found that an end point could not be obtained, since here the decomposition voltage is below 1 volt. The makers supply a separate oscillator with a frequency of about 2500 cycles per second for use when polarization effects are noticeable, but we had no opportunity of testing this. The instrument examined is also capable of application to capacity measurements, condenser loss measurements and inductance measurements. It should prove a great service in technical laboratories, and also in research laboratories where the highest accuracy is not essential. No great skill is necessary in order to obtain very good results.

# Oxford Museum of the History of Science

THE historic interest of the Old Ashmolean, Oxford, and the association of the founder of the original *Musæum Ashmoleanum* with the pioneer promoters of the new philosophy whose names were inscribed as original fellows of the Royal Society, have been referred to on many occasions in these columns, particularly in connexion with the unceasing labours of Dr. R. T. Gunther to establish a Museum for the History of Science in the Old Ashmolean Building. The purposes and scope of this Museum are not, however, widely known, so that the sequence of events which have led to the appeal for financial support in *The Times* of June 21 may be of interest.

In 1924, the University accepted from Dr. Lewis Evans the gift of a valuable collection of astrolabes and other astronomical and mathematical instruments. The donor was a member of a remarkable family, responsible for a number of entries in the "Dictionary of National Biography". He was the brother of Sir Arthur Evans, son of Sir John Evans and great-grandson of the Rev. Lewis Evans, F.R.S. (1755–1827) who became mathematical instructor at the Royal Military Academy, Woolwich, in 1799, and with whom the collection seems to have started. The gift might presumably have been housed in the Science Museum of the University, in the building of which Ruskin played a large part. But the donor had other ideas. The old Ashmolean Museum had been diverted from its original purpose. The collections of Elias Ashmole had been removed to more modern and commodious premises. In the vacated building, the School of Geography and the offices of the "Oxford Dictionary" had found a temporary home. Here Dr. Evans saw a suitable site for his collection, and the University accepted the condition.

In these circumstances of isolation, a museum, however small, needs a curator, and in this case an enthusiastic and energetic curator was readily found in Dr. R. T. Gunther, of Magdalen College. The next step is easily foreseen. A small museum under a keen curator has a natural tendency to grow, especially when the contents are of this particular kind. An obsolete instrument, which is a positive embarrassment in one place, becomes a valuable accession here. This is not to suggest that additions have been accepted without judicious care, or that the resulting collection is not an interesting and valuable one. The admission in the letter that it was difficult to forecast the position only a short time ago, must, therefore, be taken as a proof of candour rather than of any sense of intelligent anticipation.

It is candidly admitted that the University has other pressing needs; and in view of the recent comprehensive appeal on behalf of the University it seems a little difficult to understand how far the present letter claims an official character. It is signed by the Chancellor and the Vice-Chancellor; the other signatories are four Magdalen men and four Cambridge men, the last of the highest eminence in the scientific world but not perhaps very intimately acquainted with the financial position at Oxford. In the circumstances, particular importance should be attached to the unofficial element, and the plea for the Museum of the History of Science should perhaps be treated strictly on its merits, which are no doubt considerable.

An appeal of this kind raises, however, the whole question of voluntary contributions for scientific and similar purposes. Rightly or wrongly, Great Britain is committed at present to the system of voluntary hospitals. One consequence is that the bulk of public benefactions is drawn into a single channel. Very little money is left to supply the needs of culture and pure science, which elsewhere gain liberal support from voluntary sources. Here the fund is notoriously inadequate, and this fact ought always to be borne in mind when competitive claims to public assistance are put forward. The lack of means to carry on important scientific work is familiar to all those who have been connected with its administration. Thus, though the position is now rather easier through the working of international organization, for many years the Seismological Committee of the British Association was sorely hampered for want of funds. It is but fair to recall that the burden of keeping alive an infant science in Great Britain fell in that instance largely on the University of Oxford. Another example may be found in that admirable institution, the Norman Lockyer Observatory at Sidmouth, which could enlarge its activities with ease, were the necessary funds available. It is needless to multiply illustrations of a general problem.

The question arises, therefore, whether appeals to the public on behalf of individual institutions offer the most effective solution of this problem. Even the hospitals have found the advantage of organizing a central fund from which a fair distribution can be made. It seems possible that science also may have something to gain by similar action. The Government Grant Fund administered by the Royal Society is useful within a restricted range, and the same body is enabled to do more by its own endowments, which are steadily increasing. But still more could be done if the means were forthcoming. Competitive appeals, the relative merits of which can scarcely be gauged by the public, may not be the right method. It seems possible that a unified scheme administered by a competent body might produce a larger fund and a fairer distribution in accordance with the true interests of pure science. Applied science and industrial research are in a happier position, and the problem is less urgent in that field.

It is to be feared that this suggestion, even if it were found worthy of consideration, might not give much help in a case like that of the Oxford Museum of the History of Science. Just as its interests are admittedly subordinate to the needs of the teaching departments, so in a wider scheme the claims of pure research would probably take the first place. Hence the present appeal must in any event stand on its own merits, and the increasing interest taken in the history of science should ensure a satisfactory response to it. Though the main responsibility of supporting this Museum will probably fall on Oxford, the signatories to the appeal are fully justified in inviting assistance from outside the University to ensure that the Museum is provided with the relatively modest amount required for its maintenance of the valuable collections which Dr. Gunther has been so successful in bringing together, and to which he has devoted so much careful attention.

# International Engineering Congress at Glasgow

THE selection of Glasgow for the sessions of the International Engineering Congress, organized with the co-operation of the ten leading British technical institutions, not only enabled the delegates and members to visit the numerous works and industrial establishments in and around the City, but also afforded the opportunity of holding the Congress at the Empire Exhibition at Bellahouston, with its varied and extensive display of manufactures, machinery and plant. Fully a thousand members attended the Congress, representative of the United Kingdom, the Dominions, France, Germany, Italy, Belgium, Denmark, Finland, Hungary, the United States and other countries—about twenty in all.

The opening address on June 21 was delivered by the president of the Congress, Lord Weir, who declared that it is the province of the modern engineer to restore a balance of sanity in a world containing an order of society planned for the utter destruction of civilization, characterized by the minimum of international commercial intercourse, and in which the life of every individual is limited and conditioned by the constant fear of a potential enemy. "Against this sombre picture," he said, "wherein the law of the jungle appears to be the chosen principle of evolution, it is with relief that we can descry the compensating forces of science and reason."

Mr. John Colville, Secretary of State for Scotland, and Lord Elgin, president of the Exhibition Committee, also addressed the Congress and extended to the members a cordial welcome to the metropolis of Scottish industry, the latter emphasizing his view that at a moment when all the nations of the world are thinking how to protect themselves, "it is more important to think further as to what science can do and will do in making this place better than it has been—a place where we can meet together as friends."

The papers afterwards read at the meetings on June 21–23 dealt with such varied subjects as British shipbuilding, coal, municipal and industrial planning, developments in electrical engineering, the internal combustion engine, the iron and steel industry, international air transport, naval and mechanical construction in Italy, gas, and materials research, with one of appropriate local interest—the River Clyde and the Harbour of Glasgow.

Among some striking passages contained in these papers were the statements of Lord Sempill that the total mileage of airways which in 1919 was 3,000, to-day has attained a figure of much more than 300,000. Civil aircraft are now flying about 167 million miles, of which America accounts for 72 millions. The speed attained is as much as 450 miles per hour, and there is no reason why it should not be increased. An eminent French engineer, M. Mercier, president of the Union d'Electricité, stated that the total world production of electrical energy has been estimated at 310 milliard kwh. for the year 1929 and at 450 milliard kwh. for 1937. Far from having attained its limit, consumption of electricity is developing fully with very wide possibilities before it.

On the evening of June 21, the president of the Congress gave a dinner to the official delegates, which was followed by a civic reception in the City Chambers by the Lord Provost and Corporation to all the Congress members. Through the courtesy of manufacturing firms, numerous facilities were afforded for visits to local works and factories, while excursions were also made to centres of interest farther afield.

BRYSSON CUNNINGHAM.

# South-Eastern Union of Scientific Societies

## Annual Congress

FOR its forty-third annual congress, the South-Eastern Union of Scientific Societies met at Worthing on June 21–25, a five days' congress. At the inaugural meeting, Prof. Julian Huxley, who succeeded Prof. F. E. Weiss as president, took as the subject of his presidential address "Natural History, Taxonomy and General Biology". Naturalists are now engaged, he said, in tidying up and arranging the enormous number of insects and other forms of life, and those engaged in so doing call themselves taxonomists. There are more than five thousand kinds of two-winged insects in the British Isles and nearly as many beetles. Separate species of life already catalogued number somewhere about a million. Taxonomy is becoming one of the focal points of biological research. The staffs of the museums are overburdened with their share of the work. Local naturalists can take a part, and the Association for the Study of Systematics is endeavouring to form a panel of amateur workers. Prof. Huxley advocated detailed mapping of animal- and plant-life distribution. Evolution is going on all around us in the quiet country-side, just as much as in the deep sea, or the tropical jungle, although difficult to detect.

At the meeting of the Zoological Section, Sir Edward Poulton gave one of his fascinating lectures on "Lamarckian and Darwinian Conceptions of the Struggle for Existence", which was listened to with the attention due to one of so great authority. He was followed by Mr. J. Hornell, who read a paper on "Designing of Public Aquaria". After reviewing the mistakes made in the past in the aquaria at such places as Brighton, Southport, Blackpool and elsewhere, where amusement was mixed up with the attempts to teach science, he showed how he would design a future aquarium. Mr. Hornell was formerly director of fisheries to the Madras Government, and the erection under his guidance of the aquarium at Madras resulted in a great popular movement to study the contents of the tanks he installed.

"The Re-colonisation of a Burnt Patch at Cissbury" was the title of a paper by Mr. B. T. Lowne. The Jubilee and Coronation bonfires of 1935 and 1937 left a scar more than 50 ft. in diameter, with a thickness of some 8 inches of ash. These sterilized the soil to some depth. The creeping thistle was the first plant to establish itself, followed by the blackberry. Several plants not native to the spot made an appearance, notably the evening primrose, but this may have been carried to the spot in the footwear of one of the builders of the fire. Late visits to the spot showed that thirty-nine species of plants have established themselves and downland plants are gradually again growing there. Mr. Lowne also exhibited a hybrid between two species of geranium which he discovered on the Downs, and found that the hybrids had bred true, many specimens having been found.

Miss E. Gerard, curator of the Worthing Museum, showed maps of Sussex from the earliest times of map-making, including a copy of the Armada map and another of the Palmer map of 1587. The many changes in the coast-line were clearly shown.

Other papers of a high order were contributed, amongst them being "Geology of the Selborne District", by Dr. C. P. Chatwin, "Recent Progress in the Study of Insect Migration", by Dr. C. B. Williams, "The Coastal Plain", by Mr. C. T. Gaster and Mr. E. C. Martin, "British Herbals of the 17th Century", by Dr. T. A. Sprague, and "A Proposed Survey of Chalk Springs and Bournes", by Mr. F. H. Edmunds.

It was announced that John Selden's cottage, known as 'Lacies', at Salvington, where Selden was born in 1584, had been offered as a freehold to the Worthing Corporation by Mr. Alfred W. Oke.

The Union having been requested to arrange for the delivery of the Alexander Pedler Lecture of the British Science Guild, now incorporated in the British Association, this was entrusted to Prof. H. L. Hawkins, who took as his subject "Humanity in Geological Perspective". After discussing many outwarn theories, he said that he suspected that true geological knowledge is even now held but by the few, and is brushed aside by those who have it but do not wish to own its teachings. Truth, chivalry and kindness are, he said, inconsistent with the struggle for existence, but nevertheless the 'idealist', who faces noble thoughts, is a man. "Men can learn ; their capacity for appreciating wisdom shows that its acquisition is not beyond their powers. And wisdom, which makes men human, is better than the rubies of material success that may leave him bestial."

The excursions were very varied, suiting all tastes, visits to Cissbury, Amberley, Sompting, the Broadwater Waterworks, the Angmering Roman Villa, Swanbourne and the Arun, and the Highdown House Gardens having been arranged.

A reception at the Town Hall was given to members by the Mayor and Mayoress, Councillor and Mrs. W. C. Birkett, whose co-operation in making the Congress a success was greatly appreciated by the Union.

## Scientific and Industrial Research in Australia

THE eleventh annual report of the Council for Scientific and Industrial Research, Commonwealth of Australia, which covers the year ended June 30, 1937, refers to the establishment of a Fisheries Section to conduct researches into Australian Fisheries problems. This is at present housed in temporary quarters but a properly trained staff is being built up while the problems determining the location of the research station are being reviewed and an investigation vessel is under construction. Experimental flights have already indicated that aerial observations can considerably assist the work of the investigation vessel. Considerable progress was also made during the year in the provision of adequate laboratory facilities. The Forest Products Laboratory was officially opened on April 7, 1937; the Viticultural Research Station, Merbein, has been occupied and it was anticipated that the headquarters laboratories and experimental cool stores of the Section of Food Preservation and Transport and the new Animal Health Laboratory would be ready for occupation at the end of 1937.

The Division of Plant Industry has continued its investigation into plant pasture problems as well as of physiological diseases of fruit in the field and disorders following storage. Evidence has been obtained that high soil temperatures increase resistance to pest-seedling development of flag-smut in certain varieties of wheat and lowers it in others. In the fumigation of seed beds for control of downy mildew or blue mould of tobacco, benzene vapour always gave the best results and attention is being turned to control under field conditions. The Division of Economic Entomology has given much time to the sheep blowfly pest, including studies both of the sheep and the flies as well as the prevention and treatment of strike. Search has been made for substitutes for lead arsenate in insecticides for codling moth sprays, and a good deal of the Division's time has been occupied with work on the biological control of noxious weeds, as well as on chemical methods of weed control. Investigations by the Animal Health laboratories have again ranged over a wide field including bovine mastitis, studies in fleece chemistry and fibre measurement, fertility in sheep, dairy products research, and in addition the Animal Nutrition Laboratory at Adelaide has been responsible for investigations on phosphorus metabolism of sheep and on coast disease.

The Forest Products Division's investigations also cover a wide field from the seasoning of timber, timber physics, wood structure and utilization to the preservation of wood where the value of arsenicals as termiticides in Australia and of sodium silicofluoride for protection against *Lyctus* attack has been established. Many important investigations have also been carried out at the Viticultural Research Station on irrigation and drainage as well as by the Food Preservation Section, including investigations on chilled beef such as loss of bloom, on diseases of bananas and their control, citrus packing house problems, including the colouring of citrus fruits, and problems relating to the storage and diseases of apples, pears, plums, peaches, etc.

## Science News a Century Ago

### Jean Marc Gaspard Itard (1775-1838)

JULY 5 marks the centenary of the death of this famous pioneer in otology, who was born in 1775 at Oraison, a small town in Provence. At nineteen years of age, he became assistant to the celebrated surgeon Larrey at Toulon, and afterwards accompanied him to Paris, where he studied medicine under Pinel and Corvisart. He qualified with a thesis on pneumothorax, and shortly afterward was appointed physician to the Institute for Deaf Mutes, where he gained a great reputation by his detailed study of the idiot boy known as the "Sauvage de l'Aveyron". His chief work, on the composition of which he spent eleven years, entitled "Traité des maladies de l'oreille et de l'audition", appeared in 1821, and a second edition was published posthumously in 1842. He invented an acoumeter which was the first instrument of its kind, as well as a form of Eustachian catheter and an instrument for the improvement of hearing. He was also the author of articles on stammering, intermittent fever and dropsy, and translated Willich's book on domestic hygiene. In 1816 he became joint editor of the *Journal Universel des sciences médicales* and in 1822 of the *Revue Médicale*, while in 1832 he was made editor of the "Dictionnaire de Médecine".

### Launch of the *Robert F. Stockton*

ON July 7, 1838, Lairds of Birkenhead launched the iron screw steamer *Robert F. Stockton* which, being sent to the United States the following year, became the first screw-driven vessel to be used for practical purposes in that country. She was built to the order of Captain R. F. Stockton (1795–1866), of the United States Navy, and fitted with the screw propeller invented by John Ericsson. She was 63·4 ft. long, 10 ft. beam, 7 ft. deep, 33 tons register and 33 horse-power. She was fitted with a two-cylinder engine driving the propeller shaft directly and not through gearing. In January 1839, she carried out trials in the River Thames, when she successfully towed four coal barges from Southwark to Waterloo Bridge. Referring to her trials, *The Times* said that they appeared "quite conclusive as to the success of this important improvement in steam navigation". The vessel was sent to America under sail, and afterwards was used as a steam tug on the Delaware and Rariton Canal, being renamed the *New Jersey*.

### Supply of Pure Milk

ON July 7, 1838, the *Mechanics' Magazine* contained a communication from J. Fordred directing attention to an essay on milk supply by M. Barreul recently published in Paris. The essay contained a remarkable review of the methods used for adulterating milk. Some of the more wealthy inhabitants, it said, who obtained their milk direct from the dairies, at a good price, had it pure, but the mass of milk sold in Paris was more or less adulterated with water, brown sugar, flour or emulsion of sweet almonds. It was suggested, therefore, that the authorities should ordain that no milk should be sold except in sealed measures and that in each quarter of the city one or two pharmacists should be charged with the duty of examining the milk from time to time. Penalties were proposed for every fraudulent alteration in quality or quantity.

## University Events

CAMBRIDGE.—Dr. A. J. Bradley has been appointed assistant director of research in crystallography, and Dr. J. E. Driver University demonstrator in the Department of Chemistry.

The Vice-Chancellor gives notice that the John Humphrey Plummer professorship of mathematical physics will be vacant on October 1 by the resignation of Prof. R. H. Fowler. Preference will be given to candidates whose work is connected with theoretical atomic physics. The stipend of the professor is £1,200 a year or, if he holds a fellowship with dividend, £1,000 a year. Candidates for the professorship are requested to communicate with the Vice-Chancellor and to send him, on or before July 20, ten copies of any statement or testimonial which they desire to submit to the electors. If testimonials and references are sent, they should not, taken together, exceed four in number.

Dr. B. C. Saunders, University demonstrator in chemistry, has been elected to a fellowship at Magdalene College. Dr. Saunders was placed in the first class of the Natural Sciences Tripos, Part I, in 1924, and the first class in Part II of the same Tripos in 1925, in which year he was elected to the Beatson Scholarship at Pembroke College. Since 1931 he has been Charles Kingsley lecturer and director of studies in natural sciences and medicine at Magdalene College.

J. R. F. Jeffreys, of Downing College, has been elected to the Sheepshanks Exhibition for 1938.

H. Davenport, of Trinity College, has been approved for the degree of doctor of science.

LONDON.—Sir Robert Pickard has been re-elected vice-chancellor for the year 1938–39. Dr. A. M. H. Gray has been appointed deputy vice-chancellor for the same period.

Dr. J. D. Boyd has been appointed to the University chair of anatomy tenable at the London Hospital Medical College as from the beginning of next session. Since 1937 he has been University lecturer in anatomy in the University of Cambridge.

It has been resolved that, on the occasion of the celebration of Foundation Day 1938, the following honorary degrees, among others, should be conferred: Sir Charles H. Bressey, the degree of doctor of science (engineering); Sir Robert Ludwig Mond, the degree of doctor of science; Prof. A. W. Pollard, the degree of doctor of literature.

Prof. J. H. Clapham has been appointed Creighton lecturer for the year 1938–39.

The following doctorates have been conferred: D.Sc. in anatomy on Prof. Thomas Nicol, University professor at King's College; D.Sc. in biochemistry on Mr. B. C. J. G. Knight, University College; D.Sc. in botany on Mr. Hugh Dickson, Imperial College—Royal College of Science.

OXFORD.—J. D. Lambert has been elected to an official fellowship as lecturer in natural science at Trinity College, in succession to Prof. C. N. Hinshelwood.

SYDNEY.—At the Annual Commemoration Ceremony on May 14, the opportunity was taken of presenting to Dr. W. L. Waterhouse, acting-dean of the Faculty of Agriculture of the University of Sydney, the Farrer Memorial Medal. This is the third occasion on which the medal in honour of the world-famous wheat-breeder has been awarded.

# Societies and Academies

## Paris

Academy of Sciences, May 9 (*C.R.*, **206**, 1333–1420).

LOUIS COUFFIGNAL : A problem of abstract mechanical analysis : the theory of reduction, result of mechanical functions.

R. DE MISÈS : The infinitesimal element of order $n$ of a skew curve.

HUSNI HAMID : The hypercongruence of Euclidian space of $n + 1$ dimensions.

BÉLA DE SZ. NAGY : Series of multiply monotone factors.

ALEXANDRE OSTROWSKI : Some transformations of the series of Liouville-Neumann.

MLLE. MARIE CHARPENTIER : The Peano points of certain systems of differential equations.

ALEXANDRE GHIKA : The determination of analytical functions.

SILVAIN WACHS : Some properties of pseudo-conformal transformations with an invariant frontier point.

ETIENNE ŒHMICHEN : The teachings of natural flight and their applications to flying machines capable of hovering in the air.

JEAN TILHO : Remarks on the helicostat.

ASSÈNE DATZEFF : The mean distribution of the electrons in a complex atom.

BENJAMIN DE JEKHOWSKY : A criterion for the identification of small planets. A simplification of the methods of calculation of the criterion of Luc Picart.

V. A. NICOLSKY : Method of calculation of plates of unequal moments of inertia.

AURELIO MARQUES DA SILVA : The materialization of a photon in the field of an electron.

JEAN VIRGITTI : The theoretical study of a transport of ions by a current of vapour used for obtaining high potentials.

NICOLAS PERAKIS, TRYPHON KARANTASSIS and LÉANDRE CAPATOS : The measurement of the atomic (magnetic) moment of tetravalent rhenium.

YEOU TA : The repetition of the whole of the vibration spectrum of organic molecules in the neighbourhood of each of the frequencies (CH) of vibration, fundamental or harmonic.

ANDRÉ GUINIER : The diffusion of X-rays under very small angles applied to the study of fine particles and to colloidal suspensions.

GEORGES CARPÉNI : The preparation, electrometry and ultra-violet spectrography of glucoheptо-ascorbic acid.

PIERRE BONNEMAN and MARC BASSIÈRE : The condensed phosphoric acids. The polyphosphates.

FÉLIX TROMBE : The isolation of metallic europium. The electrolysis of europium chloride in the eutectic mixture of potassium and sodium chlorides with a cadmium cathode gives a cadmium europium alloy from which the cadmium can be removed by heating in argon under reduced pressure at carefully controlled temperatures. The final product contains 98 per cent of europium.

ROGER LAUFFENBURGER and MICHEL BRODSKY : Study of the system $Na_2HPO_4 + 2NH_4Cl \rightleftarrows 2NaCl + (NH_4)_2HPO_4$.

JEAN BARON and PAUL LAFFITTE : The inflammation of normal propyl ether. The pressure-temperature of inflammation curves are analogous with those of ethyl ether, and, as was found with the latter, the addition of nitrogen to the mixtures of oxygen and ether lowers the temperature of inflammation.

GUSTAVE VAVON and ROGER MATHIEU : The hydrogenation of halogen derivatives by platinum black.

VICTOR MADSEN : The Caledonian chain of northern Greenland.

CHRISTIAN POULSEN : The Ozarkian in Greenland.

GEORGES CHOUBERT and LOUIS NELTNER : The Pre-Cambrian of the western Anti-Atlas.

JEAN FELDMANN and MLLE. GENEVIÈVE MAZOYER : The *iodugues* of *Asparagopsis armata*.

JEAN RENAUD : The existence of the dicaryon in a *Saccharomyces* isolated from the vine.

MLLES. BERTHE DELAPORTE and NADIA ROUKHELMAN : The presence of thymine in the nucleic acid extracted from yeast. Cytological and chemical researches.

PIERRE CHOUARD : The experimental production of buds under the influence of the heteroauxins.

RENÉ SOUÈGES : The embryogeny of the Illecebraceae [Scleranthaceæ]. The development of the embryo in *Scleranthus perennis*.

JEAN CUZIN : Evidence of the remarkable constancy in the regime of growth in the germination of pollen.

MME. CÉCILE SOSA-BOURDOUIL : The comparative composition of spores and pollens of vascular plants.

RAYMOND CAHEN and MME. ANDRÉE TRONCHON : The action of zinc on the œstrogenic effects of folliculine in the ovariectomized rat. Zinc chloride increases the intensity and prolongs the duration of the œstrogenic effects of folliculine in the ovariectomized rat provided that the ratio of zinc to hormone lies between certain limits.

MME. VÉRA DANTCHAKOFF : The mechanism of the sexual deviations resulting from (*a*) treatment with testo-sterone, (*b*) free-martinism, (*c*) tumours of the suprarenal capsule (virilism).

AUGUSTE SARTORY, RENÉ SARTORY and JACQUES MEYER : The influence of certain water-soluble vitamins on the velocity of growth of various coccoform bacteria.

ANDRÉ BOIVIN and MME. LYDIA MESROBEANU : The chemical nature and biological properties of the *Vi* antigen of the typhoid bacillus.

## Moscow

Academy of Sciences (*C.R.*, **18**, No. 8 ; 1938).

I. I. PRIVALOV : Different classes of subharmonic functions considered from the point of view of their analytic representation.

V. S. IGNATOVSKIJ : The Laplace transformation (10).

D. SHIN : (1) Existence theorems for the quasi-differential equation of the $n$th order. (2) The solutions of the self-adjoint differential equation $u[n] = \lambda u$, $I(l) \neq 0$ in $L_2(0, \infty)$. (3) The quasi-differential transformations in Hilbert space.

LOO-KENG HUA : Some results on Waring's problem for smaller powers.

N. LUSIN : A theorem of the theory of equations with partial derivatives.

N. MOISSEIEV : (1) The convergence of the series representing formally the simple periodic solutions. (3) The generalized Jacobian stability of a periodic trajectory.

H. MANDEL : Born's electrodynamics and cosmology.

G. S. LANDSBERG and V. S. MALYSHEV : Combination spectra of the solutions of water in dioxane and pyridine.

K. ALEXEEVA: Long-period radioactivity in silver, cæsium and indium activated by slow neutron bombardment.

S. M. KATCHENKOV: Absorption spectra of praseodymium and neodymium in heavy water.

S. L. MANDELSTAM: The intensity of spectral rays in an arc with carbon electrodes.

W. STOCKMANN: Some characteristic moments of the horizontal mixing of water masses of the Caspian Sea in the system $S = f(t)$.

N. N. MALOV: Contribution to the theory of the electrical conductivity of objects liable to polarization.

P. KHOMIKOVSKY and P. REHBINDER: Dependence of stabilization and wetting of particles suspended in oil medium on the quantity of the surface-active substance adsorbed.

I. I. ČERNIAJEV: (1) Cleve's triamine. (2) The *cis*-tetramine of quadrivalent platinum.

N. N. KURNAKOV, I. I. KORNILOV and G. B. BOKY: 'Ruby' slag from the thermite process for the production of metallic chromium.

A. M. NEGRUL: Evolution of cultivated varieties of grapes.

I. A. KOSTIUČENKO: Winter hardiness of plants as influenced by vernalization of ripening seed-grains.

G. V. ZABLUDA: Action of soil drought on the formation of generative organs in spring wheats.

I. SUKHORUKOV, E. KLING and K. OVČAROV: The effect of *Phytophthora infestans* de Bary on the ferments of affected plants.

V. T. EREMENKO: Intermediate period of development and anatomo-morphological characters of the light stage in wheat.

M. CH. ČAJLACHJAN: Motion of blossom hormone in girdled and grafted plants.

V. G. ALEXANDROV and O. G. ALEXANDROVA: Full and meagre grain in soft wheat.

## Tokyo

Imperial Academy (*Proc.*, **14**, No. 4, April 1938).

SAEMON TARÔ NAKAMURA and YOSIO KATÔ: Variations in the magnetic dip in Central Japan.

HANTARO NAGAOKA and TADAO MISHIMA: Some chemical actions of hydrogen excited by electrodeless discharge. The action of excited hydrogen on various chemical compounds is described.

EIJI OCHIAI and TOSIHARU NAKAMURA: On our knowledge of the so-called 2-nitrosomorphins.

GAKURO IMAMURA and MASAO KOTANI: Crustal blocks.

YOSITIRO UMEYA: Developmental characteristics of the silkworm embryo.

KIN-ICHIRO HANAOKA: Sex modification in a semi-differentiated salamander, *Hynobius retardus*, resulting from implantation of testis and hypophysis.

TOKI-O YAMAMOTO: Contractile movement of the egg of a bony fish, *Salanx microdon*. Contraction is shown to occur on the yolk sphere, while the blastoderm itself remains still. The protoplasmic layer surrounding the yolk during early stages of development is considered responsible for this contractile movement. It is suggested that the movement functions as a stirrer in order to facilitate the absorption of yolk.

KIYOSHI TAKEWAKI: (1) Effect of testis graft on the adrenal of the mouse. (2) Note on a subcutaneously transplanted mouse testis with spermatogenetic activity.

# Forthcoming Events

[*Meeting marked with an asterisk is open to the public.*]

INSTITUTE OF PHYSICS (MANCHESTER AND DISTRICT BRANCH), July 4–5.—Conference on Elasticity and Plasticity to be held in the University of Manchester.*

MUSEUMS ASSOCIATION, July 4–9.—Annual Conference to be held in Belfast.

# Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

VEGETABLE SPECIALIST in the Punjab Agricultural Service, Class I—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (July 7).

LECTURER IN PRODUCTION ENGINEERING in the Dudley and Staffordshire Technical College, The Broadway, Dudley—The Principal (July 7).

JUNIOR LECTURER IN ELECTRICAL ENGINEERING in the Military College of Science, Woolwich, S.E.18—The Commandant (July 8).

LECTURER IN MECHANICAL ENGINEERING in the Central Technical College, Suffolk Street, Birmingham, 1—The Chief Education Officer (July 9).

LECTURER IN MECHANICAL ENGINEERING in the North Staffordshire Technical College—The Clerk to the Governors, Education Offices, Town Hall, Hanley, Stoke-on-Trent (July 9).

LECTURER IN CHEMISTRY and LECTURER IN PHARMACEUTICAL CHEMISTRY in University College, Nottingham—The Registrar (July 11).

ASSISTANT LECTURER AND DEMONSTRATOR IN CHEMISTRY in King's College for Household and Social Science, Campden Hill Road, London, W.8—The Secretary (July 11).

ASSISTANT LECTURER IN THE DEPARTMENT OF BUILDING, Huddersfield Technical College—The Principal (June 13).

HEAD OF THE BIOLOGY DEPARTMENT, Huddersfield Technical College—The Principal (July 13).

JUNIOR LECTURER IN SCIENCE in the Royal Military Academy, Woolwich, S.E.18—The Under-Secretary of State (C.5), The War Office, London, S.W.1 (July 16).

UNIVERSITY LECTURER IN MATHEMATICS in the University of Cambridge—Dr. H. M. Taylor, Clare College, Cambridge (July 16).

PLUMMER PROFESSOR OF MATHEMATICAL PHYSICS in the University of Cambridge—The Vice-Chancellor (July 20).

PROFESSOR OF PHYSIOLOGY in the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 88a Gower Street, London, W.C.1.

# Reports and other Publications

(*not included in the monthly Books Supplement*)

## Great Britain and Ireland

Report by His Majesty's Government in the United Kingdom of Great Britain and Northern Ireland to the Council of the League of Nations on the Administration of the Tanganyika Territory for the Year 1937. (Colonial No. 148.) Pp. iv+251+1 map. (London: H.M. Stationery Office.) 4*s.* net. [176

The Insurance Man and his Trade. By Harry Henry. ("Fact", No. 15.) Pp. 92. (London: "Fact".) 6*d.* [176

Education in Nazi Germany. By Two English Investigators. Pp. 72. (London: Kulturkampf Association.) 1*s.* [176

## Other Countries

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 90: The Occurrence of Flints and Extinct Animals in Fluvial Deposits near Clovis, New Mexico. Part 5: Diatom Evidence from the Mammoth Pit. By Ruth Patrick. Pp. 15–24. (Philadelphia, Pa.: Academy of Natural Sciences of Philadelphia.) [176

Anales del Museo Argentino de Ciencias Naturales. Tomo 39: Antropología, Etnología y Arqueología. Publicación No. 80: Investigaciones arqueológicas en Sorcuyo, Puna de Jujuy. Por Eduardo Casanova. Pp. 423–456+6 plates. (Buenos Aires: Museo Argentino de Ciencias Naturales.) [176

Memoirs of the Kyancutta Museum. No. 5: An Outline of "Biosophy" (Part 1). By R. Bedford. Pp. 39–65+1 plate. (Kyancutta, S. Australia: Kyancutta Museum.) 1*s.* 6*d.* [176

Indian Forest Records (New Series.) Vol. 3, No. 9: New Indian Curculionidæ (Col.). By Sir Guy A. K. Marshall. Pp. ii+159–184+1 plate. 10 annas; 1*s.* Vol. 4, No. 1: A Guide to the Insects of Dalbergia Sissoo for Forest Officers. Pp. ii+42. 1 rupee; 1*s.* 9*d.* (Delhi: Manager of Publications.) [176

Report of the Botanical Survey of India for 1936–37. Pp. 11. (Calcutta: Government of India Press.) [176

Records of the Botanical Survey of India. Vol. 12, No. 2: (1) The Flora of the Lushai Hills, by Cecil E. C. Fischer; (2) Some New North-west Himalayan Mosses, by H. N. Dixon and R. L. Badhwar. Pp. ii+75–179. (Delhi: Manager of Publications.) 1.6 rupees; 2*s.* 3*d.* [176